INSTRUCTIONS

Type CW-20A/AW
(MM-20A/AW)

and

Type MM-26A/AW
Microwave Relay
Standby Switchover Equipment

RADIO CORPORATION OF AMERICA
COMMUNICATION PRODUCTS DEPARTMENT, CAMDEN, N. J.

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FIRST AID

WARNING!

Operation of electronic equipment involves the use of high voltages which are dangerous to life. Operating personnel must at all times observe all safety regulations. Do not change tubes or make adjustments inside the equipment with voltage supply on. Under certain conditions dangerous potentials may exist in circuits with power controls in the off position due to charges retained by capacitors, etc. To avoid casualties, ALWAYS DISCHARGE AND GROUND CIRCUITS PRIOR TO TOUCHING THEM.

ABOUT FIRST AID

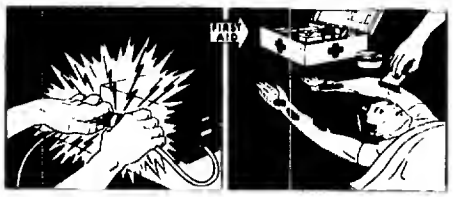
Personnel engaged in the installation, operation and maintenance of this equipment or similar equipment are urged to become familiar with the following rules both in theory and in the practical application thereof. It is the duty of every redlomen to be prepared to give adequate First Aid and thereby prevent avoidable lose of life.

FIRST DEGREE BURN

SKIN REDDENED. Temporary treatment—Apply baking soda or Unguentine.

SECOND DEGREE BURN

SKIN BLISTERED. Temporary treatment—Apply baking soda, wet compress, white petroleum jelly, follie jelly, olive oil, or tea.



THIRD DEGREE BURN

FLESH CHARRED. Temporery treetment—Apply baking soda, wet compress, white petrolsum jelly, or foille eprey. Treet for severe shock.

BACK PRESSURE ARM LIFT METHOD
OF ARTIFICIAL RESPIRATION
(Courtesy of the American Red Cross)

1. Position of the subject (See Fig. 1)

Place the subject in the face down, prone position. Bend his elbows and place the hands one upon the other. Turn his face to one side, placing the cheek upon his hands.

FIGURE 1

2. Position of the operator (See Fig. 2)

Kneel on either the right or left knee at the head of the subject facing him. Place the knee at the side of the subject's head close to the forearm. Place the opposite foot near the elbow. If it is more comfortable, kneel on both knees, one on either side of the subject's head. Place your hands upon the flat of the subject's back in such a way that the heels lie just below a line running between the armpits. With the tips of the thumbs just touching, spread the fingers downward and outward.

FIGURE 2

3. Compression phase (See Fig. 3)

Rock forward until the arms are approximately vertical and allow the weight of the upper part of your body to exert slow, steady, even pressure downward upon the hands. This forces air out of the lungs. Your elbows should be kept straight and the pressure exerted almost directly downward on the back.

4. Position for expansion phase (See Fig. 4)

Release the pressure, avoiding a final thrust, and commence to rock slowly backward. Place your hands upon the subject's arms just above his elbows.

5. Expansion phase (See Fig. 5)

Draw his arms upward and toward you. Apply just enough lift to feel resistance and tension at the subject's shoulders. Do not bend your elbows, and as you rock backward the subject's arms will be drawn toward you. Then lower the arms to the ground. This completes the full cycle. The arm lift expands the chest by pulling on the chest muscles, arching the back, and relieving the weight on the chest.

FIGURE 3

THE CYCLE SHOULD BE REPEATED 12 TIMES PER MINUTE AT A STEADY, UNIFORM RATE. THE COMPRESSION AND EXPANSION PHASES SHOULD OCCUPY ABOUT EQUAL TIME, THE RELEASE PERIODS BEING OF MINIMUM DURATION.

Additional related directions:

It is all important that artificial respiration, when needed, be started quickly. There should be a slight inclination of the body in such a way that fluid drains better from the respiratory passages. The head of the subject should be extended, not flexed forward, and the chin should not sag lest obstruction of the respiratory passages occur. A check should be made to ascertain that the tongue or foreign objects are not obstructing the passages. These aspects can be cared for when placing the subject into position or shortly thereafter, between cycles. A smooth rhythm in performing artificial respiration is desirable, but split-second timing is not essential. Shock should receive adequate attention, and the subject should remain recumbent after resuscitation until seen by a physician or until recovery seems assured.

FIGURE 4

FIGURE 5

NOTICE

This book contains instructions for standby switchover stations using Terminal Switchover Equipment MI-31022-B or MI-31022-C and Repeater Switchover Equipment MI-31021-B or MI-31021-C. Although the material is presented in terms of MI-31022-B and MI-31021-B, all the information contained in this book can be applied as well to switchover equipment MI-31022-C and MI-31021-C with the following exceptions: Figures 19, 21 and 32 apply to MI-31022-B only and Figures 19A, 21A, and 32A apply to MI-31022-C only. In all other places in the book, with the above exceptions, where MI-31022-B is mentioned it can be replaced by MI-31022-C and MI-31021-B can be replaced by MI-31021-C.

The MI-31022-B, -C and MI-31021-B, -C switchover equipment may also be used with MM-26A station equipment as well as with CW-20A (MM-20A) station equipment. A standard CW-20A (MM-20A) station becomes an MM-26A station by using Transmitter MI-31007 or MI-31132-2, Receiver/Modulator MI-31102, and Duplex Filter MI-31113 in place of Transmitter MI-31490 or MI-31132-1, Receiver/Modulator MI-31491 and Duplex Filter MI-31497. All later versions of any of the associated CW-20A (MM-20A) and MM-26A basic equipment units may be used interchangeably with the units described in this book. For example, Transmitter MI-31132-1 (see figures 22 and 27) is directly interchangeable with Transmitter MI-31490 in CW-20A (MM-20A) station equipment.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

CW-20A (MM-20A) LIST OF EQUIPMENT (†)

Description	*MI*	*Terminal Station with Terminal Service Unit and Standby Switchover Equipment*		*Thru Repeater Station with Repeater Service Unit and Standby Switchover Equipment*		*Drop Channel Repeater Station with Repeater Service Unit and Standby Switchover Equipment*	
		T2C Cabinet	*T2R Rack*	*R4C Cabinet*	*R4R Rack*	*D4C Cabinet*	*D4R Rack*
Transmitter	MI-31490	2	2	3	3	3	3
Receiver/Modulator	MI-31491	2	2	3	3	3	3
Terminal AFC Unit	MI-31492	2	2				
Baseband Amplifier	MI-31493	2	2			1	1
Power Supply	MI-31494	2	2	2	2	2	2
Repeater Service Unit	MI-31495			1	1	1	1
Terminal Service Unit	MI-31496	1	1				
Duplex Filter	MI-31497-A (**)	1	1	2	2	2	2
Cable, Universal	MI-31499-A22					1	1
Cable, Universal	MI-31499-B18	1	1	2	2	2	2
Cable, Baseband	MI-31499-B25	1	1				
Cable, Baseband	MI-31499-B29			1	1	3	3
Cable, Baseband-Term	MI-31499-D18	1	1				
Cable, Baseband-Term	MI-31499-D28	1	1	2	2		
Cable, Baseband-Term	MI-31499-D40					1	1
Cable, Baseband-Term	MI-31499-D54	1	1				
Cable, R. F.	MI-31031-16	1	1				
Cable, R. F.	MI-31031-20	1	1				
Cable, R. F.	MI-31031-25	1	1	1	1	1	1
Cable, R. F.	MI-31031-34	2	2	4	4	4	4
Cable, R. F.	MI-31031-37			2	2	2	2
Cable, R. F.	MI-31031-40			1	1	1	1
Cable, R. F.	MI-31031-50	1	1	2	2	2	2
Chassis with Jones Plug (5¼")	MI-31009-5			1	1		
Blank Chassis (5¼")	MI-31010-5	4	4	3	3	3	3
Blank Chassis (7")	MI-31010-7	2	2	2	2	2	2
Termination Panel	MI-31011	1	1	1	1	1	1
Handset	MI-31019-A	1	1	1	1	1	1
Repeater Switchover Equipment	MI-31021-B, -C			1	1	1	1
Terminal Switchover Equipment	MI-31022-B, -C	1	1				
Filter Mtg. Kit	MI-31024-A	1					
Filter Mtg. Kit	MI-31024-B			1		1	
Filter Mtg. Kit	MI-31024-C		1				
Filter Mtg. Kit	MI-31024-D				1		1
Rack Channel Frame Type	MI-31025-H84		2		2		2
Trans. Rear Shield	MI-31026-A		2		3		3
Repeater Ant. Switching Unit	MI-31029-B			1	1	1	1
Crystal (specify freq.)	MI-31687-K (**)	2	2				
Air Filter Kit	MI-31027	2 (*)	2 (*)	3 (*)	3 (*)	3 (*)	3 (*)
Fuse Kit	MI-31082-B	1	1	1	1	1	1
Cabinet	MI-30922-A84	2		2		2	
Standby Lockout Unit	MI-31055 (***)	2	2	2	2	2	2

(*) TC2/F or T2R/F indicates addition of two dust filter kits MI-31027.
R4C/F, R4R/F, D3C/F or D3R/F indicates addition of three filter kits MI-31027.

(**) Suffix number is determined by station frequency assigments.

(***) Required only when MI-31491-A Receiver/Modulators are used.

(†) This table shows the typical radio equipment rack requirements for the three basic types of microwave stations and is intended for use only as a guide list. It may also be used as a guide list for the MM-26A stations by substituting Transmitter MI-31007 or MI-31132-2 for MI-31490 or MI-31132-1, Receiver/Modulator MI-31102 for MI-31491 and Duplex Filter MI-31113 for MI-31497..

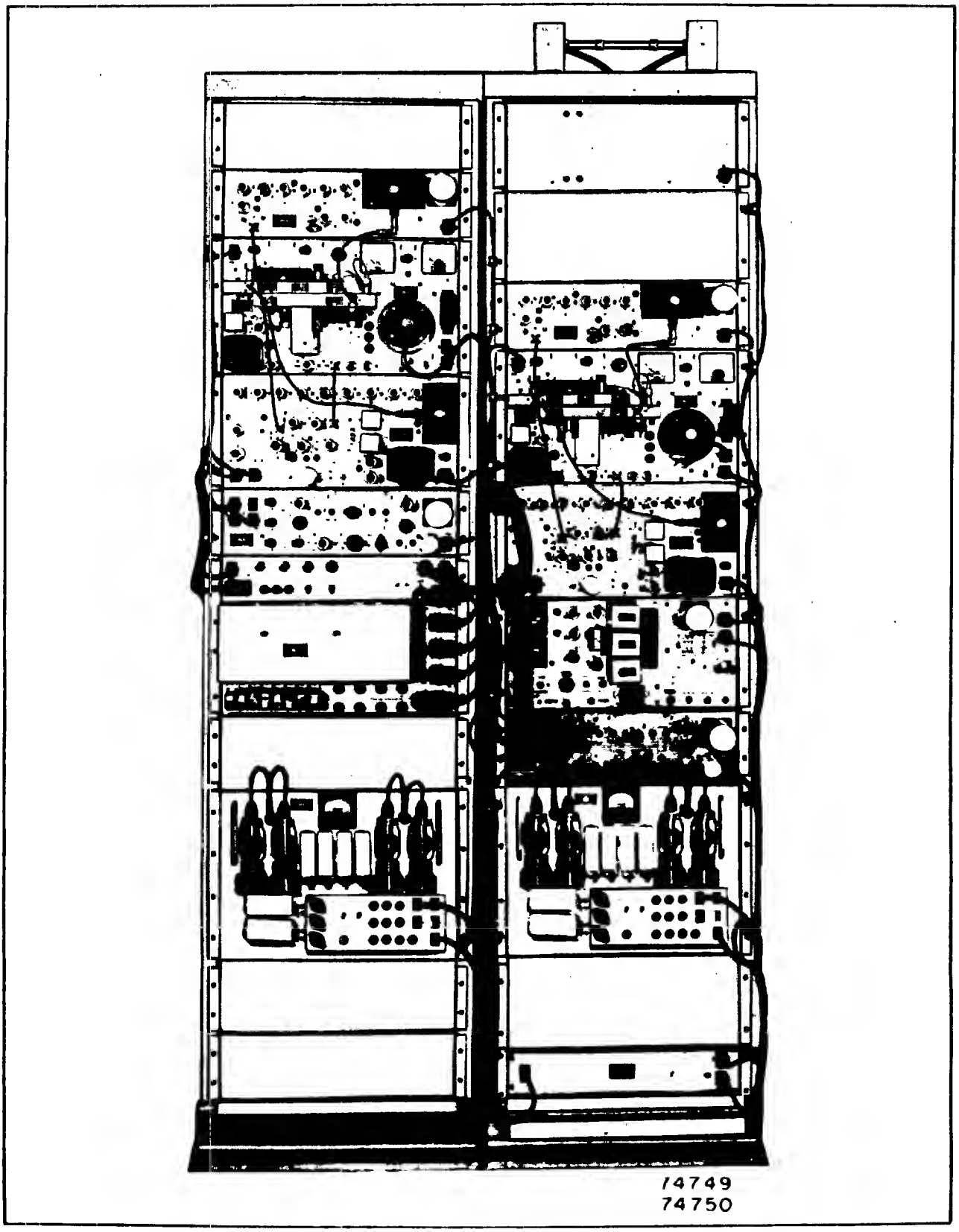


Figure 1—CW-20A (MM-20A) Terminal Standby Station—Open Rack

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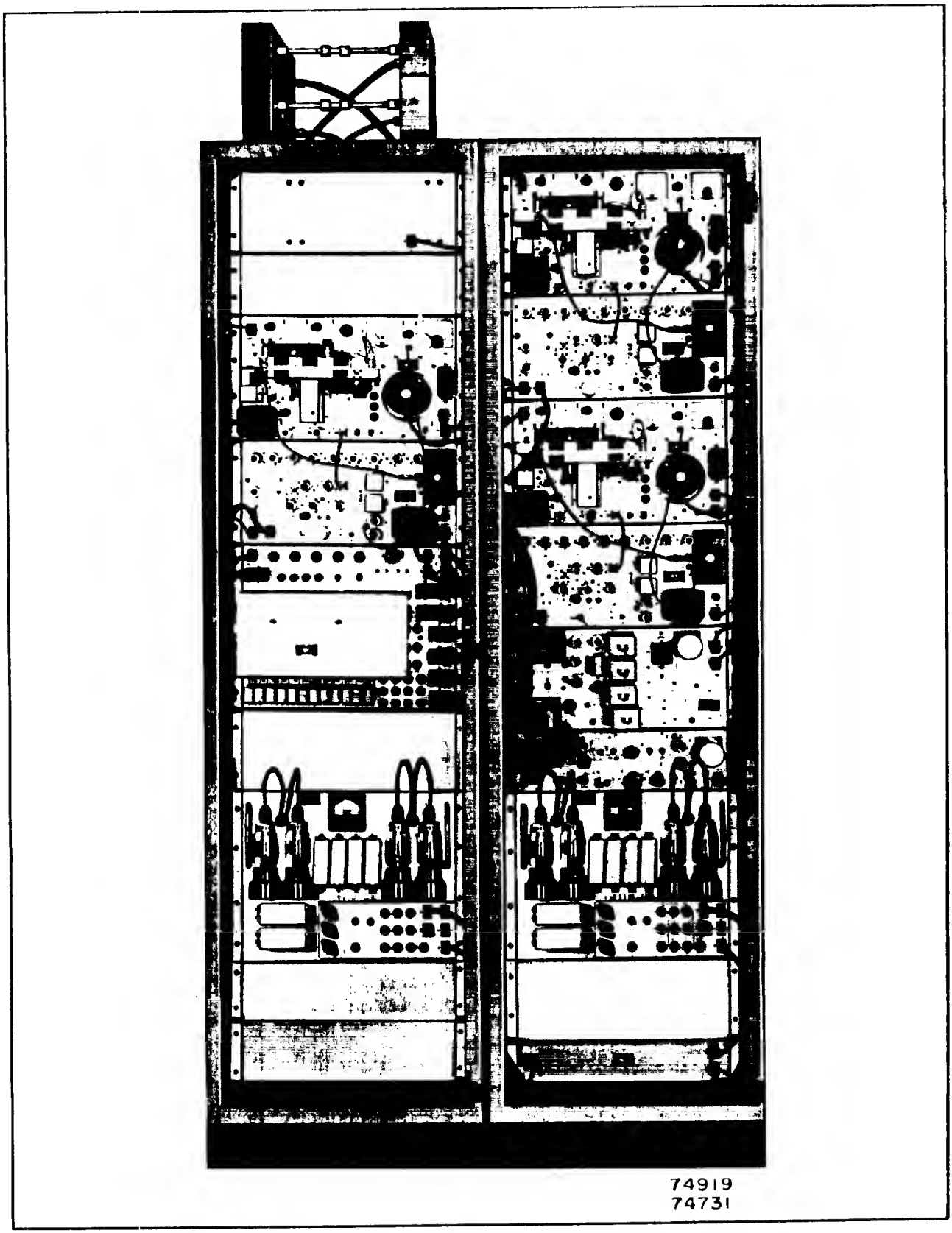

Figure 2—CW-20A (MM-20A) Repeater Standby Station—Cabinet Rack

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CW-20A (MM-20A) STANDBY SWITCHOVER EQUIPMENT

TECHNICAL DATA

TERMINAL SWITCHING UNIT MI-31022, -A, -B, -C, ITEM 1

Relay Power

115 v ac
250 v dc
500 v dc

Relay

Symbol	*Function*
10K1	Warm-Up Delay
10K2	Transmitter Fault Enabling/Disabling
10K3	Power Supply Fault Enabling/Disabling
10K4	Power Supply Switching, Master
10K5	Receiver Fault Lock-In
10K6	Radio Equipment Switching, Master
10K7	Receiver Fault Delay
10K8	Power Supply Switching, A.C. Power Transfer
10K9	Power Supply Switching, D.C. Power Transfer
10K10	Radio Equipment Switching, D.C. Power Transfer
10K11	Radio Equipment Switching, A.C. Power Transfer
10K12	Radio Equipment Switching, Baseband Transfer
10K13	Power Supply Fault Sensing, A.C. Reg
10K14	Power Supply Fault Sensing, A.C. Unreg.
10K15	Power Supply Fault Sensing, D.C.
10K16	Radio Equipment Switching, Standby AFC Delay
10K17	Transmitter Fault Re-enabling

Fuses

Symbol	*Panel Marking*	*Rating*	
10F1	SW UNIT AC	1A	32 V
10F2	COM 250 V	0.15A	250 V
10F3	COM ACR	0.8A	250 V
10F4	TERM 250 V	0.4A	250 V
10F5	TERM 500 V	0.3A	250 V
10F6	TERM ACU	0.8A	32 V
10F7	TERM ACR	1A	32 V
10F8	STDBY 250 V	0.4A	250 V
10F9	STDBY 500 V	0.3A	250 V
10F10	STDBY ACU	0.8A	250 V
10F11	STDBY ACR	1A	32 V

All fuses are Bussman type MDM Fusetrons or equivalent.

Controls

10S1—LINE
10S2—TEST PWR
10S3—MAN SW TO STDBY-TERM
10S4—MAN SW TO STDBY-PWR SUP
10S5—RESET

Lamps

10I1—STANDBY
10I2—TERM
10I3—TEST
10I4—LINE

Weight and Dimensions

Weight—25½ lbs.
Height—12¼"
Depth—4½" Back of Panel—4" Front of Panel
Width—19" Rack Mounting

TERMINAL ANTENNA SWITCHING UNIT MI-31022, -A, -B, -C, ITEM 2

Relay Power

115 v ac

Weight

Weight—9 lbs.

Dimensions

Height—7"
Depth—10" Overall
Width—19" Rack Mounting

REPEATER SWITCHING UNIT MI-31021, -B, -C

Relay Power

115 v ac
250 v dc
500 v dc

Relays

Symbol	*Function*
9K1	Warm-Up Delay
9K2	Transmitter Fault Enabling/Disabling
9K3	Power Supply Fault Enabling/Disabling

TECHNICAL DATA

REPEATER SWITCHING UNIT MI-31021, -B, -C

Relay

Symbol	*Function*
9K4	Power Supply Switching, Master
9K5	Receiver Fault Lock-In
9K6	E-W Switching, Master
9K7	W-E Switching, Master
9K8	E-W Receiver Fault
9K9	W-E Receiver Fault
9K10	Power Supply Switching, A.C. Power Transfer
9K11	Power Supply Switching, D.C. Power Transfer
9K12	E-W Switching, A.C. Power Transfer
9K13	E-W Switching, D.C. Power Transfer
9K14	E-W Switching, Baseband Transfer
9K15	W-E Switching, A.C. Power Transfer
9K16	W-E Switching, D.C. Power Transfer
9K17	W-E Switching, Baseband Transfer
9K18	Power Supply Fault Sensing, A.C. Reg.
9K19	Power Supply Fault Sensing, A.C. Unreg.
9K20	Power Supply Fault Sensing, D.C.
9K21	Radio Equipment Switching, Standby AFC Delay
9K22	Receiver Fault Delay
9K23	Transmitter Fault Re-enabling

Fuses

Symbol	*Panel Marking*	*Rating*	
9F1	SW PANEL AC	1A	32 V
9F2	COM 250 V	0.15A	250 V
9F3	COM ACR	0.8A	250 V
9F4	E-W 250 V	0.3A	250 V
9F5	E-W 500 V	0.3A	250 V
9F6	E-W ACU	0.8A	250 V

Fuses

Symbol	*Panel Marking*	*Rating*	
9F7	E-W ACR	0.8A	250 V
9F8	W-E 250 V	0.3A	250 V
9F9	W-E 500 V	0.3A	250 V
9F10	W-E ACU	0.8A	250 V
9F11	W-E ACR	0.8A	250 V
9F12	STDBY 250 V	0.3A	250 V
9F13	STDBY 500 V	0.3A	250 V
9F14	STDBY ACU	0.8A	250 V
9F15	STDBY ACR	0.8A	250 V

All fuses are Bussman type MDM Fusetrons or equivalent.

Controls

9S1—LINE
9S2—TEST PWR
9S3—MAN SWITCH TO STANDBY—E-W
9S4—MAN SWITCH TO STANDBY—W-E
9S5—MAN SWITCH TO STANDBY—PWR SUP
9S6—RESET

Lamps

9I1—STANDBY
9I2—W-E
9I3—E-W
9I4—TEST
9I5—LINE

Weight and Dimensions

Weight—31 lbs.
Height—14"
Depth—4½" Back of Panel—4" Front of Panel
Width—19" Rack Mounting

REPEATER ANTENNA SWITCHING UNIT MI-31029, -A, -B

Relay Power

115 v ac

Weight

Weight—15 lbs.

Dimensions

Height—7"
Depth—10" Overall
Width—19" Rack Mounting

STANDBY LOCKOUT MI-31055

Power Required

Filament 6.3 v ac (from receiver/modulator)
B+ 250 v (from receiver/modulator)

Relay

16K1—Lockout Relay

Tubes

Symbol	*Type*	*Function*
16V1	RCA 12AX7	Audio Amplifier
16V2	RCA 12AT7	Audio Amplifier and DC Amplifier

Control

16R4—Noise Gain

STANDBY STATION POWER REQUIREMENT

Terminal Standby Station—585 Watts
Repeater Standby Station—835 Watts

DESCRIPTION

GENERAL

The CW-20A (MM-20A) Standby Switchover Equipment is designed for installation with CW-20A (MM-20A) microwave relay station equipment to provide automatic switchover from the main microwave station equipment to a duplicate set of standby equipment in the event a fault develops in the main receiver, transmitter or power supply. This will assure uninterrupted station operation.

Standby switchover equipment can be installed in any type of CW-20A (MM-20A) microwave relay station, either the terminal, drop repeater or thru repeater station. The switchover equipment can be included as part of the complete equipment at the initial station installation or it may be installed at standard CW-20A (MM-20A) stations already in operation which do not contain standby switching facilities. To convert a standard CW-20A (MM-20A) microwave station to a standby station, the installation of a separate rack containing the necessary standby radio equipment and power supply is required in addition to the switchover equipment. The equipment that constitutes a complete terminal standby station, thru repeater standby station or drop repeater standby station is shown in the List of Equipment on page 5.

At a terminal standby station the terminal switching unit, standby radio equipment, and standby power supply are installed in a separate rack located at the left of the main equipment. The terminal antenna switching unit is located in the top rack position of the main equipment rack. At a repeater standby station the repeater switching unit, antenna switching unit, standby radio equipment and standby power supply are installed in a separate rack located at the left of the main equipment rack.

Terminal Switchover Equipment MI-31022-B provides the standby switchover function at terminal stations. It is composed of a terminal switching unit which switches in the standby units, and a terminal antenna switching unit which changes the antenna connections from the main to the standby equipment.

Repeater Switchover Equipment MI-31021-B in conjunction with *Repeater Antenna Switching Unit MI-31029-B* provides standby switchover function at either drop or thru repeater stations.

Standby Lockout Unit MI-31055 must be installed in the MI-31491-A receiver/modulator units at all stations having standby switchover operation. MI-31491-B receiver/modulator has this unit as an integral part of its assembly. The function of this standby lockout circuit is to prevent switchover to standby radio equipment when the incoming microwave signal fails while the receiver is functioning normally.

At a terminal station equipped with standby switching, a main transmitter or receiver fault switches all of the units of standby equipment into operation except the standby power supply. The standby radio equipment is then powered by the main power supply. A main power supply failure switches the standby power supply into service to power the main radio equipment. A main transmitter or receiver failure and a main power supply failure switches all of the standby units into service in place of the main equipment at a terminal station or in place of the E-W or W-E equipment at a repeater station.

At a repeater half standby station a main transmitter or receiver fault (E-W for example) switches the standby radio equipment into operation in place of the E-W radio equipment. If the fault occurs in the W-E (instead of E-W) radio equipment, the standby radio equipment will be switched into operation in place of the W-E radio equipment. In either case, the operating radio equipment (E-W and standby or W-E and standby) will continue to receive power from the main power supply, provided no previous power supply fault has occurred, with resulting switchover to operation of the standby power supply.

A main power supply fault switches the standby power supply into operation to power the radio equipment operating at the time of the power supply fault (E-W and W-E, E-W and standby or W-E and standby).

A standard CW-20A (MM-20A) terminal or repeater station can be converted to a standby station by the addition of the proper standby switching units and standby microwave equipment

units. The CW-20A (MM-20A) List Of Equipment on page 5 shows the complete list of components which comprise each of the three basic types of standby stations, namely: (1) Terminal Station with Terminal Service Unit and Standby Equipment, (2) Thru Repeater Station with Repeater Service Unit and Standby Equipment and (3) Drop Repeater Station with Repeater Service Unit and Standby Equipment. By the use of this equipment list, the customer is able to ascertain what additional components are needed to convert a standard CW-20A (MM-20A) microwave station to a standby station, or what components are required for a complete installation of each of the three basic types of standby stations.

In installations using MI-31491-A Receiver/Modulator, an MI-31055 Standby Lockout Unit must be installed in both the main and standby receivers. At terminal standby stations with MI-31491-A receiver/modulators, MI-31022-A switchover equipment is used. At repeater standby stations with MI-31491-A, MI-31021 switchover equipment is used. When MI-31491-B receiver/modulator is used, the functions of MI-31055 are incorporated as an integral part of the receiver-modulator so that MI-31055 is not required. MI-31491-A and MI-31491-B differ only in the inclusion of the lockout circuits. The tubes and relays for the standby lockout circuit of MI-31491-B are included in MI-31022-B or MI-31021-B for both the main and standby receiver/modulators. Tubes 12AU7 and 12AT7 serve as 2V17 and 2V18 respectively and the relay as 2K3. At terminal standby stations with MI-31491-B receiver/modulators, MI-31022-B switchover equipment is used At repeater standby stations with MI-31491-B receiver/modulators, MI-31021-B switchover equipment is used. MI-31022-A is the same as MI-31022-B and MI-31021 is the same as MI-31021-B except that MI-31022-B and MI-31021-B include the tubes and relays for the lockout circuit of MI-31491-B.

TERMINAL SWITCHOVER EQUIPMENT MI-31022-B

The main and standby radio equipments at a terminal standby station each consists of the following major equipment units: One Transmitter of series MI-31490, one Receiver/Modulator of series MI-31491, one Terminal AFC Unit of series MI-31492, one Baseband Unit MI-31493 or MI-31120. The main and standby power supplies each consist of one Power Supply of series MI-31494. In addition, the terminal station with standby includes the following "common" equipment, which operates at all times whether main or standby radio equipment or power supply is in use: one Terminal Switchover Equipment MI-31022-B, -C, one Terminal Service Unit MI-31496, and one Termination Panel, MI-31011 or MI-31056.

The standby radio equipment will be switched into operation by either a main transmitter or main receiver fault and the standby power supply will be switched into operation by a main power supply fault.

Terminal Switching Unit MI-31022-B, Item 1, (figure 3) performs the function of switching the standby radio equipment and/or standby power supply into operation at a terminal standby station in the event of a main radio (receiver or transmitter) and/or power supply fault. It contains the necessary relays and associated components for switching the input and output connections of each main equipment unit (except the "common" equipment) to an identical standby unit.

The standby radio equipment at a terminal standby station will be switched into operation when there is an appreciable decrease in transmitter r-f power output. The switchover is initiated by the transmitter fault sensing device, meter relay 1M2. This meter, in conjunction with crystal rectifier 1CR1, gives a relative indication of output power. When the power fails to the point where the black needle of 1M2 comes in contact with the adjustable red needle, the relay contacts of 1M2 close and cause relay 7K6 in the terminal service unit to operate. Relay 7K6 closes contacts which (1) operate buzzer 7H3; (2) cause lamp 7H1, the transmitter fault lamp (identified by "T" on the panel), to light; and (3) initiate immediate transfer to operation of the standby radio frequency equipment.

After the faulty transmitter has been repaired, the main radio equipment can be restored to operation by pressing RESET button, 10S5, on the terminal switching unit. Normal operation will then be restored within one minute.

If the IF amplifier in the main receiver/modulator should fail, a fault indication is sent to the terminal switching unit. At this point there is a delay of six seconds, intended to eliminate false switchover to standby due to transients. On completion of this delay, if the indication of receiver fault still persists, switchover to operation of stand-

by radio equipment takes place, and fault information is passed on to the terminal service unit. Here the fault information operates relay 7K5, which in turn causes buzzer 7I13 to buzz, and lamp 7I12, the receiver fault lamp (identified by "R" on the panel), to light.

After the fault has been corrected, normal operation is restored within one minute after the RESET button is pressed. If the 2C39A tubes in the main transmitter are old, the transmitter may be slow to build up power. If this happens, there is a possibility that a transmitter fault will be indicated and the equipment will switch back to standby after about 55 seconds. If this occurs, the RESET button should be immediately pressed again, and normal operation will result.

When the standby radio equipment is switched into operation by either a receiver or transmitter fault the antenna is switched from the main radio equipment to the standby radio equipment by the action of the terminal antenna switching unit.

The terminal switching unit contains three relays which sense faults in the main power supply. If any of the four output voltages (250 volts, dc, 500 volts dc, ac unregulated, and ac regulated) of the power supply fail, immediate transfer to operation of the standby power supply will result. The terminal switching unit will send power supply fault information (same as receiver fault information) to the terminal service unit causing the buzzer to sound and lamp "R" to light.

After the main power supply has been repaired, it can be restored to operation by pressing the RESET button.

Switchover to operation of standby radio frequency equipment and standby power supply are completely independent of one another. When the RESET button is pressed, however, all main equipment will be restored to operation, regardless of whether the standby radio frequency equipment, the standby power supply, or both have been operating.

CONTROLS

1. LINE switch, 10S1, is the power switch for the station. The power switches (5S1 and 5S2) in both main and standby power supplies should be left closed at all times, and 10S1 used as the "on-off" switch for the station.

2. *TEST PWR* switch, 10S2, applies input power to both main and standby power supplies when switched to "TEST" with 10S1 closed. This feature is used in trouble-shooting, as described in the "Maintenance" section.

3. *MAN. SW TO STDBY-PWR. SUP.* pushbutton 10S4, initiates transfer to operation of standby power supply. Lamp "R" of the terminal service unit will light and the buzzer will buzz.

4. *MAN. SW TO STDBY.-TERM.* pushbutton, 10S3, initiates transfer to operation of standby radio equipment. Lamp "R" of the terminal service unit will light and the buzzer will sound.

5. *RESET* pushbutton, 10S5, will restore to operation either the main radio equipment or the main power supply or both when corresponding standby equipment is operating. If the main equipment is incapable of satisfactory operation due to a fault, the standby equipment will again be automatically switched into operation within one minute.

FUNCTIONAL ANALYSIS

The following is a detailed description of the switchover operation at a terminal station with standby switching as performed by the Terminal Switchover Equipment, MI-31022-B. Refer to the block diagrams of figures 4, 5 and 6 and the schematic diagram of figure 7 as aids in following this description.

1. Normal Steady-State Condition

This condition is reached by closing the LINE switch 10S1. Within one minute after this switch is closed the terminal switching unit is prepared to perform its switchover functions when a fault occurs in the main station equipment. The following action ensues when switch 10S1 is closed.

a. Immediate Effects

Upon closure of the line switch, several different circuits are energized immediately. AC power is sent into the main power supply. From there it comes back to the switching unit, where it operates power supply fault sensing relays 10K13 and 10K14, and lights TERM lamp 10I2. This ac power then goes to the main and common equipment, as ac regulated and ac unregulated (filament and blower motor) power. In the main power supply it also lights lamp 511 and energizes timer 5K3, which has a nominal delay of 30 seconds. AC power is also sent to the antenna switching unit. It is there applied to the "normal" (corresponding to main radio equipment) coil input of the antenna relay.

The antenna relay is a mechanical latch-electrical reset device with micro switches which remove the coil voltage immediately after operation of the relay. Thus its operating and release coils

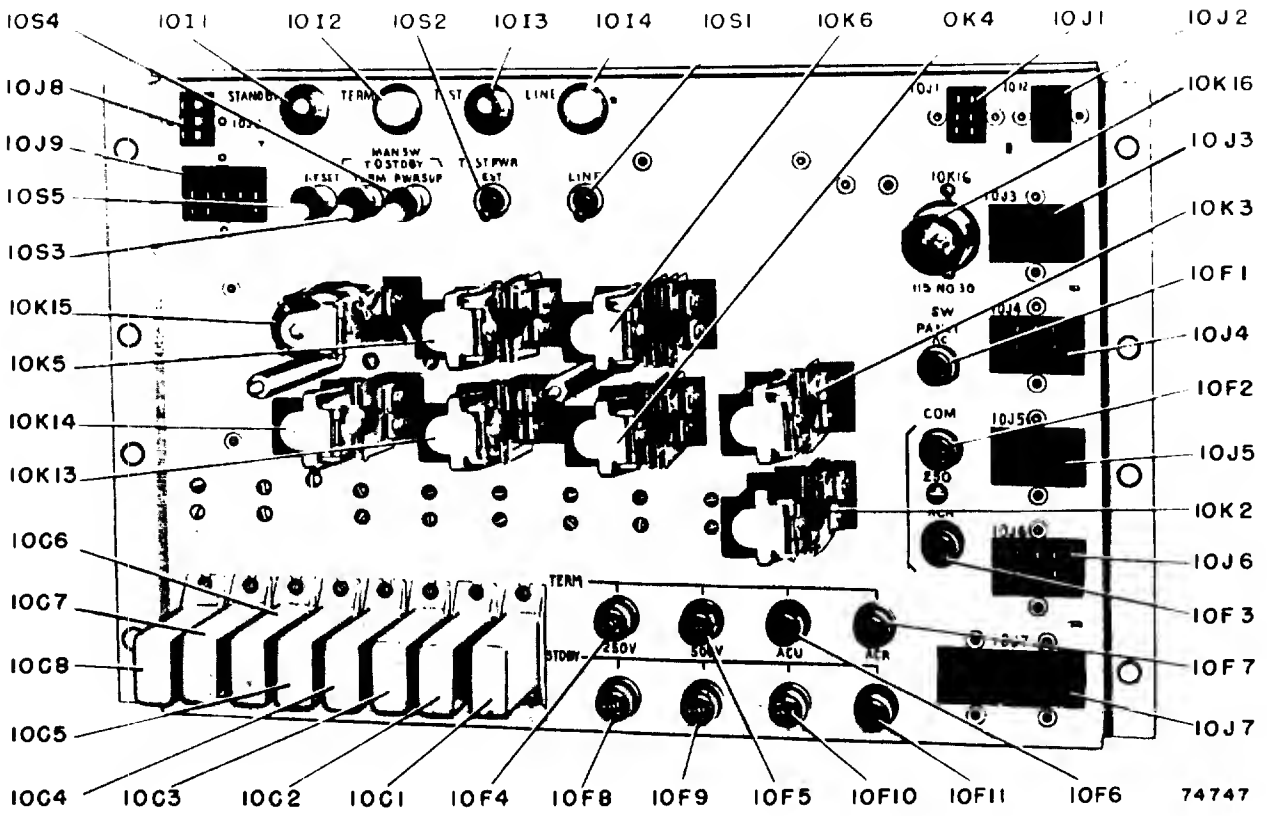

Figure 3—Terminal Switching Unit, MI-31022-B, Item 1 (front view)

are of the momentary duty type. The relay will remain in either normal or standby position until ac power is applied to the coil which will transfer it to the opposite position. (See figure 15.)

If the LINE switch 10S1 is opened when the switchover equipment is in standby condition, all the relays of the terminal switching unit will reset when power is removed, so that when it is re-applied, the main equipment will be activated. The antenna relay, however, will remain in standby condition until the LINE switch is closed again and power is applied to its "normal" coil.

When the LINE switch 10S1 is closed, ac power is also applied to the LINE lamp 10I4, indicating the "Power On" condition. Power is also applied to motor-driven timer 10K1. The purpose of this delay (0.9 minute) is to allow the main power supply and main transmitter to warm up before the associated fault circuits are enabled.

b. 30 seconds after LINE switch 10S1 is closed

Timer 5K3 in the main power supply operates and supplies input ac to the high-voltage transformers of the 250 volt and 500 volt rectifiers. The dc output of these rectifiers is fed into the terminal switching unit, and from there to the main and common equipment.

It will be noted from the schematic of figure 7 that each power connection to the main, standby, and common equipment from the switching unit is fused in the switching unit. Thus, if a short-circuit develops in the main transmitter, for example, a fuse will blow in the switching unit. The main equipment, with one of its input voltages removed, will indicate a fault and switchover to operation of standby radio frequency equipment will occur. If these switching unit fuses were not provided, a transmitter short-circuit would blow a

fuse in the main power supply, which would result in operation of the standby power supply and subsequent blowing of its corresponding fuse.

c. 0.9 minutes after LINE switch 10S1 is closed

Timer 10K1 completes its cycle and operates its contacts (3, 4 and 5) which in turn energize 10K2 and 10K3. 10K2 and 10K3 operate, performing the following functions:

10K2 Operation

(1) Normally open contact 3-4 is not connected.
(2) Normally open contact 7-8 enables the transmitter fault circuit.
(3) Normally open contact 5-6 is not connected.
(4) Normally closed contact 9-10 releases 10K1, which re-cycles in approximately one second.
(5) Transfer contact 11-12-13 locks in 10K2 through the normally closed portion of transfer contact 11-12-13 of 10K4.

10K3 Operation

(1) Transfer contact 3-4-5 is not connected.
(2) Transfer contact 6-7-8 locks in 10K3 and enables the power supply fault circuit.

The switchover equipment has now reached its normal steady—state condition.

2. Switchover to Operation of Standby Radio Equipment

The actual switchover is accomplished by relays 10K6, 10K10, 10K11 and 10K12, and the antenna relay, regardless of the type of fault initiating the switchover. The last four of these relays are operated by contacts of 10K6; therefore, the fault sensing circuits must operate 10K6. The manner in which this is accomplished will be dealt with first, followed by a description of what 10K6 and its satellite relays do. In each case, normal steady-state initial conditions as described in the preceding paragraph under "0.9 minutes after LINE switch 10S1 is closed" are assumed.

a. Transmitter Fault

When the black needle of the rf monitor 1M2 in the main transmitter falls and contacts the red needle, a ground circuit is connected which operates transmitter fault relay 7K6 in the terminal service unit, if TERMINAL FAULTS switch 7S5 is closed (in its upper position).

NOTE: This switch should normally be kept closed, otherwise it will prevent the sensing of transmitter faults and the subsequent transfer to standby operation.

The ground circuit goes through contacts 10K5-11-12-13 (which disables the transmitter fault circuit in the event of a receiver fault) and 10K2-7-8 (which disables the transmitter fault circuit during transmitter warmup and power supply switchover). These contacts are both closed however, since under normal steady-state conditions, 10K2 is operated (its normally open contact 7-8 is closed) and 10K5 is not operated (the normally closed part of its transfer contact 11-12-13 is closed).

When 7K6 operates, the contact designated "A" on the terminal service unit schematic, lights the "T" lamp on the service unit indicator panel. Its "B" contact operates relay 7K3 which operates the buzzer and locks itself in. The "C" contact of 7K6 feeds ac into the switching unit to operate 10K6, and thus initiates switchover.

b. Receiver Fault

In the event of a fault in the main receiver/modulator 30 megacycle IF amplifier, relay 2K1 in the receiver/modulator operates, and relay 16K1 in the standby lockout unit (or relay 2K3, if the receiver/modulator is MI-31491-B) does not. The transfer contact 2K1-2-3-4 disables the main transmitter AFC motor, and operates baseband squelch relay 2K2 which, through contact 2-3-4, cuts off the baseband and service channel outputs of the receiver/modulator, by breaking the B+ circuit to 2V15. Transfer contact 5-6-7 of 2K2 sends ac through the normally closed part of the transfer contact 2-3-4 of 16K1 (or 2K3). This ac is then fed to the switching unit, where it energizes motor-driven timer 10K7. This timer introduces a delay of 6 seconds to prevent undesired switchover due to transients. When it operates, its transfer contact 3-4-5 operates relay 10K5, which locks itself in with normally open contact 3-4. Normally open contact 7-8 of 10K5 feeds ac into the terminal service unit where it operates relay 7K5, if TERMINAL FAULTS switch 7S5 is closed. The "A" contact of 7K5 lights the "R" lamp of the service unit indicator panel, while the "B" contact operates 7K3, which operates the buzzer and locks itself in thru its "B" contact. The "C" contact of 7K5 is not connected.

The normally closed contact 9-10 of 10K5 releases 10K7, which recycles in less than one second. The normally closed part of the transfer contact 10K5-11-12-13 disables the transmitter fault circuit, and the normally open contact 10K5-5-6 operates 10K6, initiating switchover from main to standby radio equipment.

c. Manual Switchover to Standby

If the MANUAL SWITCH TO STANDBY TERMINAL button 10S3 is pressed, it operates relay 10K5. The sequence of action that occurs after 10K5 is energized is the same as described in 2b of page 14, resulting in switchover from main to standby radio equipment.

d. Switchover—Functions of 10K6 and Satellites

When 10K6 operates, transfer contacts 3-4-5 disables the main transmitter AFC motor by removing the "Relay Common" ac from the main receiver/modulator, and enables thermal timer 10K16 to apply "Relay Common" ac to the standby receiver/modulator after a 30 second delay. This delay prevents the standby transmitter AFC motor from running at random before the standby equipment is properly warmed up.

Transfer contact 10K6-6-7-8 operates the antenna switching relay to its standby position. Normally open contact 10K6-9-10 and normally closed contact 10K6-11-12 together act as a transfer contact which switches the terminal service unit received service channel from main to standby receiver/modulator. Transfer contact 10K6-13-14-15 performs a similar function with the transmitted service channel. Normally open contact 10K6-16-17 operates satellite relays 10K10, 10K11, and 10K12, while normally open contact 10K6-18-19 locks in 10K6.

The function of 10K10 is to transfer the 250 volt dc and 500 volt dc power from the main to the standby radio equipment. Since the transfer of such dc voltages at the currents used has a tendency to establish sustained arcs at the contacts, a power-type relay with double-break transfer contacts and resistance-capacitance arc-suppression networks is employed. Transfer contact 10K10-5-6-7-8 switches the 250 volt load, while 10K10-1-2-3-4 switches the 500 volt load.

Relay 10K11 transfers the ac regulated and ac unregulated outputs of the power supply from the main to the standby radio equipment. A power-type relay is used. Transfer contact 4-1-3 switches the ac unregulated, while contact 5-8-6 switches the ac regulated. The latter also applies power to STANDBY lamp 10I1 and to the heating element of thermal timer 10K16, which delays the activation of the standby transmitter AFC motor as described above.

Relay 10K12 transfers the baseband input and output of the radio equipment. Since these are balanced circuits, two transfer contacts are required for baseband transmitted, and two for baseband received. 10K12 contacts 3-4-5 and 6-7-8 transfer the transmitted baseband, and contacts 9-10-11 and 12-13-14 switch the received baseband.

3. Switchover to Operation of Standby Power Supply

For switchover from main to standby power supply, normal steady-state condition of the terminal switching unit is assumed.

a. Fault Sensing

Relays 10K13, 10K14 and 10K15 are the main power supply fault sensing relays. 10K13 is a 115 volt ac relay with its coil connected directly across the ac regulated output of the main power supply. It remains in the energized position under normal conditions. If the ac regulated output of the main power supply fails, 10K13 releases, operating transfer contacts 3-4-5 and 6-7-8. Contact 6-7-8 is not connected, but contact 3-4-5 operates 10K4 the master power supply switching relay, and energizes 10K17, the transmitter fault re-enabling relay. It is this operating circuit of 10K4 and 10K7 that is kept open during the initial warm-up by the power supply fault disabling contact 10K3-6-7-8.

Relay 10K14 performs exactly the same function as 10K13, except that its coil is connected across the ac unregulated output of the main power supply. Thus it monitors the blower motor power.

Relay 10K15 is a double-wound dc relay which monitors both the dc outputs of the main power supply. Each dc voltage is connected to one of the coils of this relay, through a resistor. The magnetic flux due to the two windings cancels when the two dc voltages maintain the proper ratio, and the relay does not operate. However, if one of the voltages should fall, so that the ratio gets outside specified limits, 10K15 will operate and close contacts 5-6, which operate relay 10K4 and energize 10K17.

b. Manual Switchover to Standby

MANUAL SWITCH TO STANDBY-POWER SUPPLY button 10S4 is connected in parallel with the contacts of 10K13, 10K14 and 10K15. When it is pressed, 10K4 is operated, 10K17 is energized, and a transfer to operation of standby power supply is initiated.

c. Switchover—Functions of 10K4 and Satellites

(1) 10K4 Operation

Transfer contact 10K4-11-12-13 operates satellite relays 10K8 and 10K9, the operation of which is described under "10K8 and 10K9 operation" and releases relay 10K2 in order to disable the transmitter fault circuit while power supply switching takes place and the standby power supply warms up. The action of relay 10K2 will be described under "Transmitter Fault Disabling."

Normally closed contact 10K4-9-10 assures that relay 10K2 will not be re-operated until timer 10K1 has completed its delay cycle.

Normally open contact 10K4-3-4 sends fault information to the terminal service unit, where it operates 7K5. The contacts of 7K5 light the R lamp on the indicator panel and operate 7K3 which operates the buzzer 7J13. Normally open contacts 10K4-5-6 and 10K4-7-8 are not connected.

(2) 10K8 and 10K9 Operation

10K8 is a power-type relay which transfers the ac line from the input of the main power supply to the input of the standby power supply, and also transfers the ac regulated and ac unregulated loads from main to standby power supply. Contact 2-13-1 switches the input ac high, contact 4-12-3 switches the input ac common, contact 8-10-7 switches the ac regulated load, and contact 6-11-5 switches the ac unregulated load.

10K9 is a double-break relay similar to 10K10, which was described under "Switchover to Operation of Standby Radio Equipment—Functions of 10K6 and Satellites." It also has similar arc-suppression networks. Its function is to transfer the 250 volt dc and 500 volt dc loads from the main power supply to the standby power supply. Contact 1-2-3-4 switches the 500 volt load, while contact 5-6-7-8 switches the 250 volt load.

(3) Transmitter Fault Disabling

During the period of power supply switchover and of standby power supply warmup, it is necessary to disable the main transmitter fault circuit. With no dc voltage input to the transmitter, the fault contacts of 1M2 will be closed. With no dc voltage, the transmitter fault relay 7K6 in the terminal service unit cannot operate. However, when the dc voltages are applied, if no disabling were used, 7K6 would operate before 1M2 breaks its fault contacts, and a switchover to operation of standby radio equipment would take place. Therefore, the transmitter fault circuit must be disabled until the standby power supply is sufficiently warmed up and is delivering full power.

To accomplish this, advantage is taken of the 10K1-10K2 disabling cycle used when the equipment is originally energized (see section entitled "Normal Steady-State Condition"). As mentioned under "10K4 Operation," contact 10K4-11-12-13 releases 10K2. Normally open contact 10K2-7-8 disables the transmitter fault circuit, while contacts 10K2-5-6 and 10K2-3-4 are not connected. Normally closed contact 10K2-9-10 energizes timer 10K1, and transfer contact 10K2-11-12-13, in conjunction with the now open contact 10K4-9-10, assures that relay 10K2 cannot be re-operated until timer 10K1 completes its delay cycle.

Since the coil circuit of 10K2 has been broken by contact 9K4-11-12-13, an alternate circuit is provided after a delay of 5 seconds by contact 5-7 of 10K17.

Relay 10K17 is a thermal timer with a 5 second delay, the function of which is to provide the circuit for the re-operation of 10K2 (and hence, the re-enabling of the transmitter fault circuit) after 10K1 completes its cycle.

After a delay of 0.9 minutes, 10K1 operates, and its contact 3-4-5 operates 10K2 through 10K17-5-7.

10K2 contact 3-4 closes again, but this is of no consequence, since contact 10K4-5-6, in parallel with 10K2-3-4, is already closed. 10K2-7-8 again enables the transmitter fault circuit, since by this time the standby power supply has assumed the load. Contacts 10K2-3-4 and 10K2-5-6 are not connected, 10K2-9-10 releases 10K1, and 10K2-11-12-13 locks in 10K2 through 10K17-5-7.

4. Antenna Switching

Terminal Antenna Switching Unit (Item 2 of MI-31022-B) is a rack mounting unit installed in the top-most location in the main equipment rack. It contains a relay with two coaxial contacts, which is operated when switchover takes place. The coaxial contacts switch the transmitter and receiver antenna connections. The relay is of the type which removes the energizing voltage immediately after it is operated. When operated, it is mechanically latched and remains operated until its "release" coil is energized.

This relay is controlled by the action of the master radio equipment switching relay 10K6. When a transmitter or receiver fault operates 10K6, contact 6-7-8 applies ac to the antenna switching relay "standby" (operated) coil. This switches the antenna to the standby equipment. With the fault repaired and RESET button 10S5, pressed, 10K6 is released and its contact 6-7-8 applies ac to the "normal" (release) relay coil changing the antenna from the standby radio equipment to the main radio equipment.

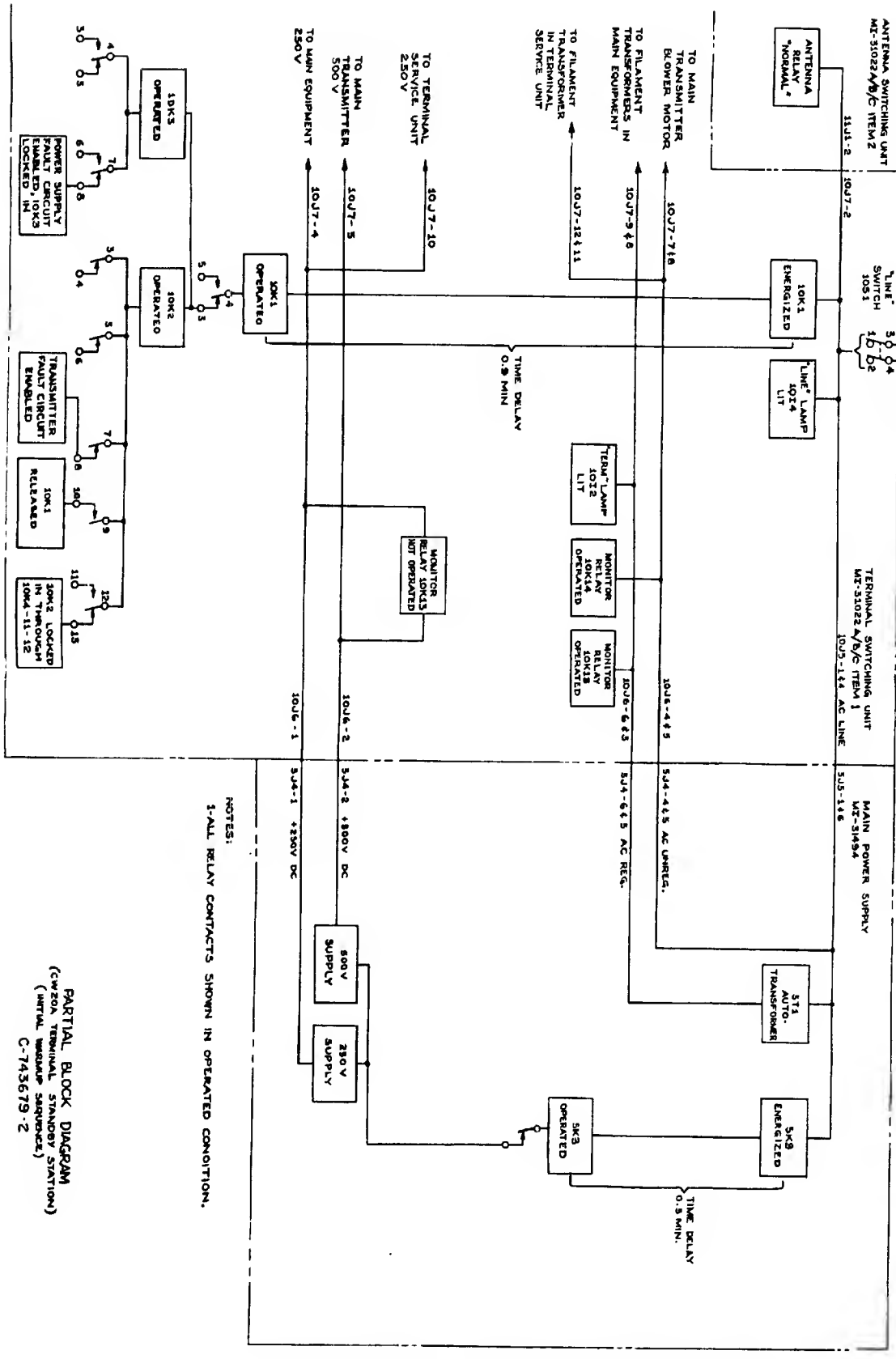

Figure 4—Terminal Standby Station Warm-up Sequence—Block Diagram

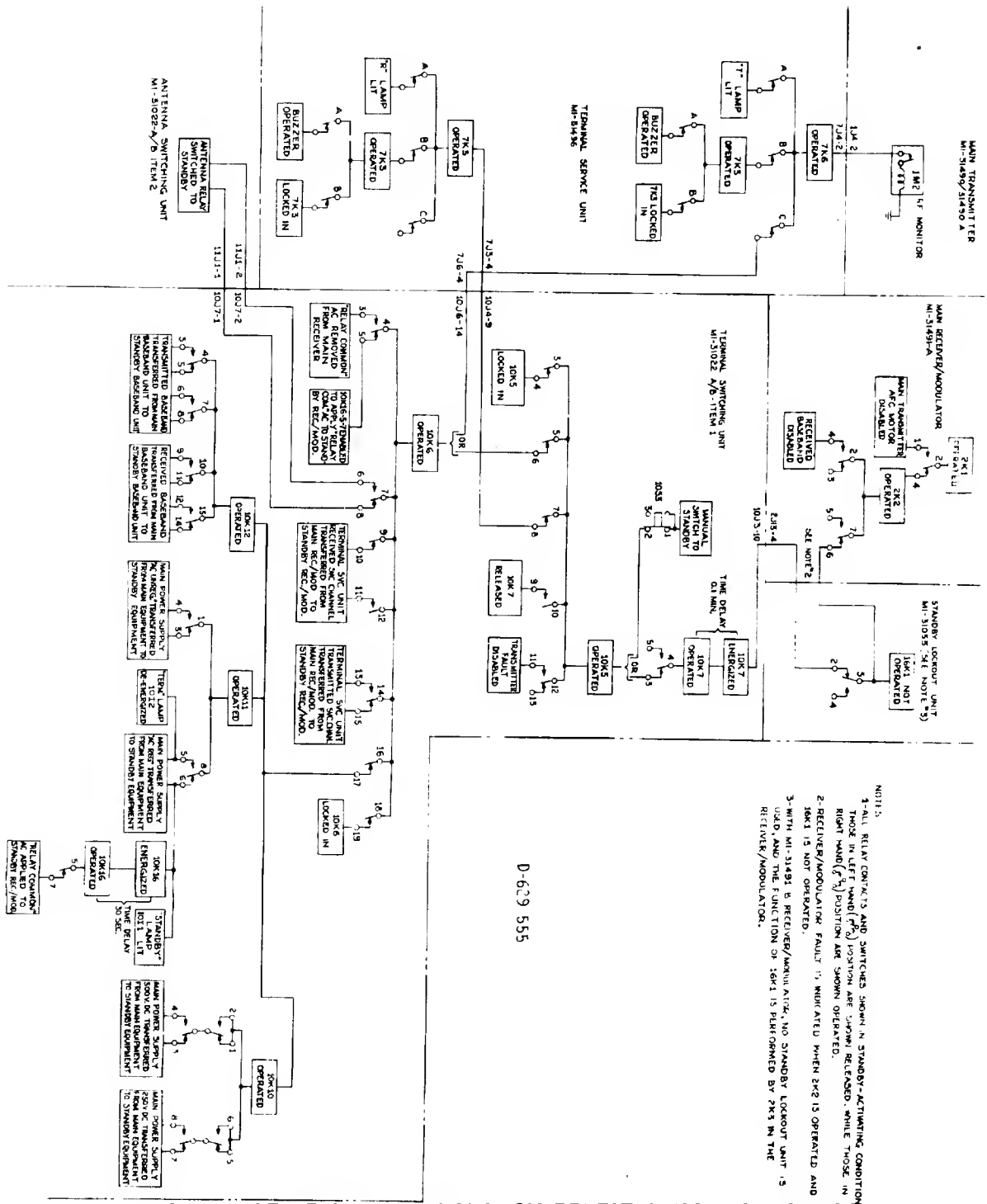

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Figure 5—Terminal Standby Station Radio Equipment Changeover—Block Diagram

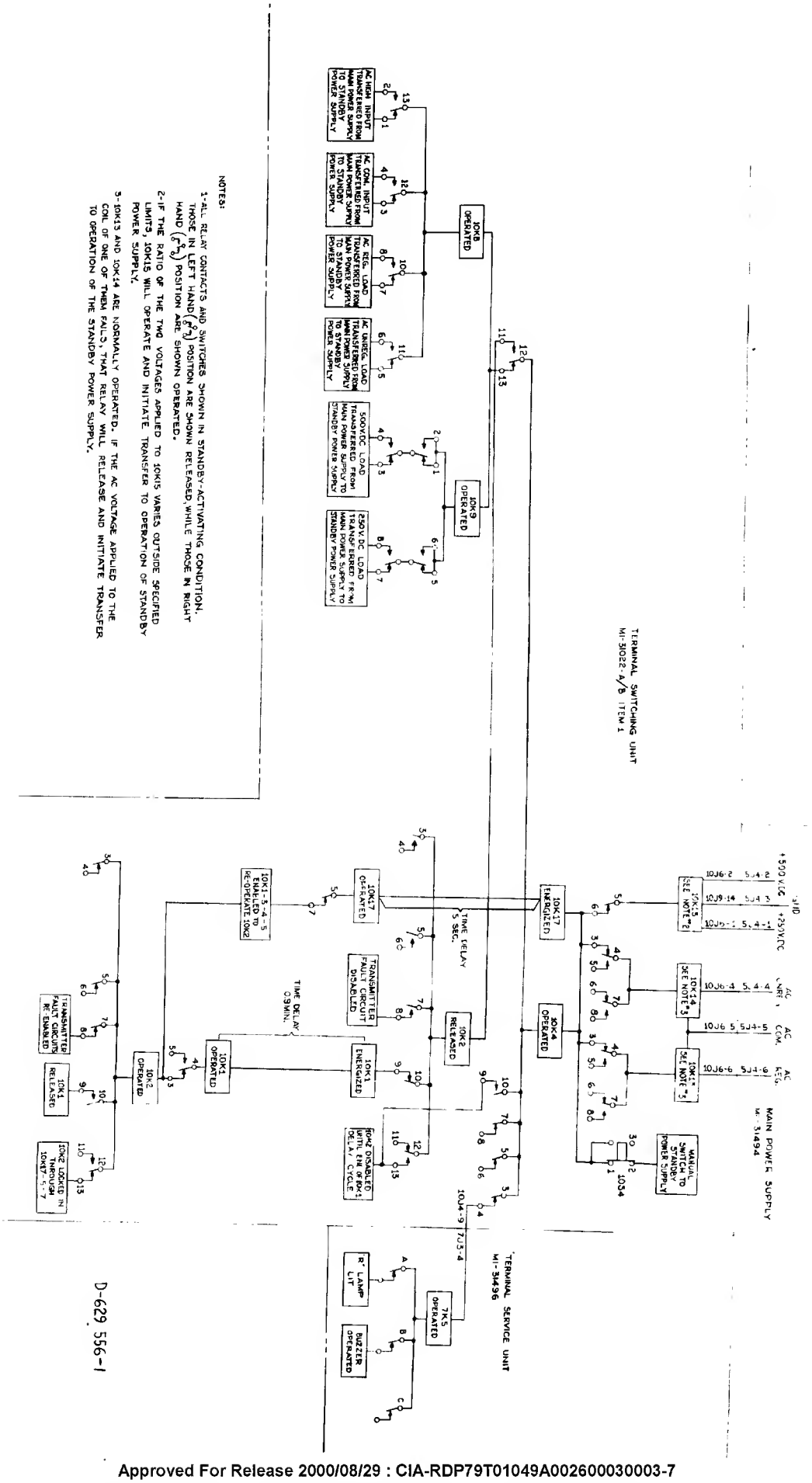


Figure 6—Terminal Standby Station Power Supply Changeover Sequence—Block Diagram

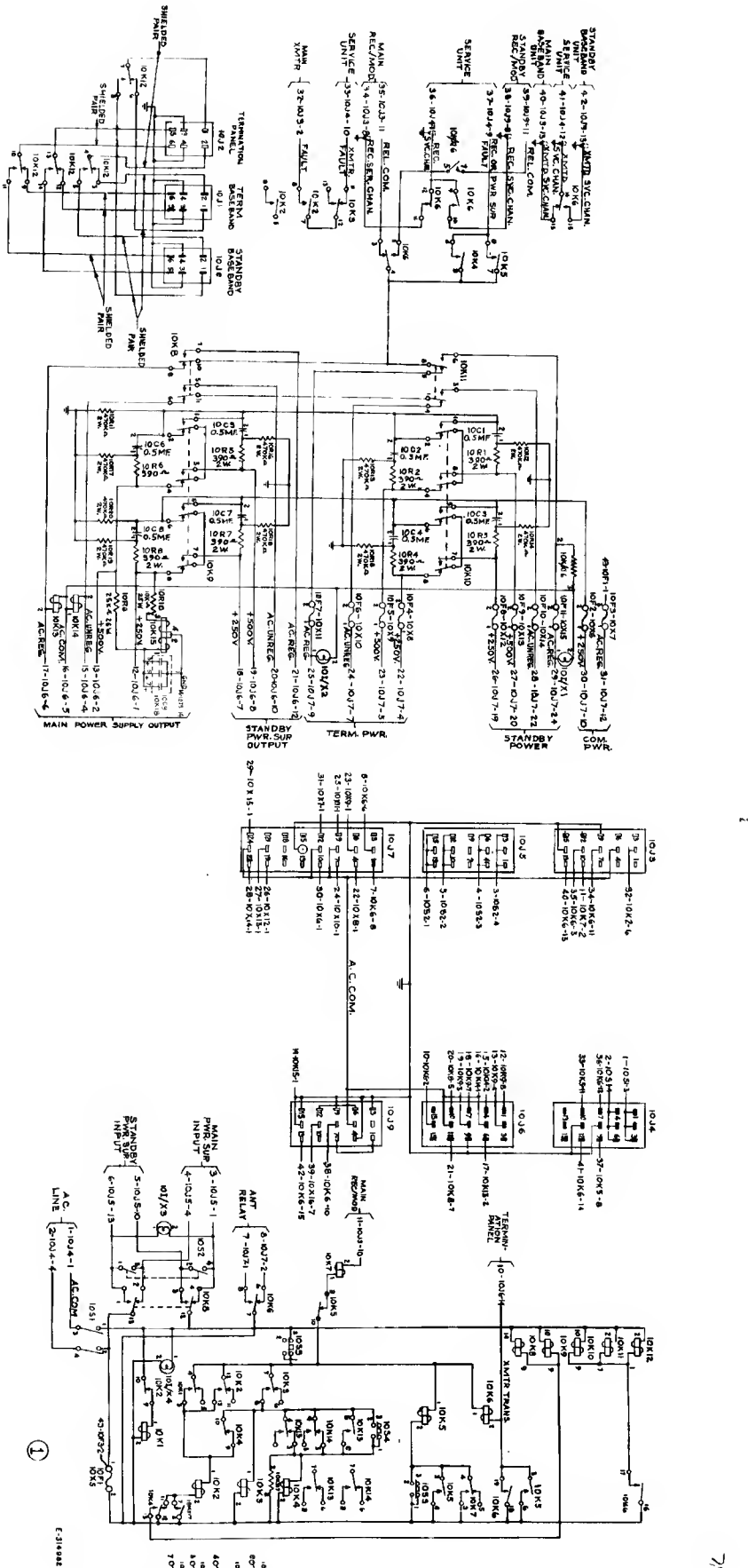


Figure 7—Terminal Switching Unit, MI-31022-B, Item 1, Schematic Diagram

5. Resetting to Operation of Main Equipment

When RESET button 10S5 is pressed, directly or indirectly it releases any operated relays in the terminal switching unit with the exception of power supply monitor relays 10K13, 10K14, and 10K15; and timers 10K1 and 10K7. If any standby equipment was in operation, transfer back to operation of main equipment is accomplished. If, however, a main receiver or transmitter fault exists, the equipment will switch back to standby operation within 60 seconds. Relay 10K6, in releasing, operates the antenna relay to its "normal" position. Relay 10K2, in releasing, disables the transmitter fault circuit and starts 10K1 on its delay cycle. Relay 10K3, in releasing disables the power supply fault circuit. At this moment, the conditions, insofar as the switching unit is concerned, are the same as those that prevail when LINE switch 10S1 is initially closed. The sequence of operations which follow within the switching unit is described under "Normal Steady-State Conditions"

REPEATER SWITCHOVER EQUIPMENT MI-31021-B

The E-W, W-E, and standby radio equipments at a repeater standby station each consist of the following major equipment units: one Transmitter of series MI-31490 and one Receiver/Modulator of series MI-31491. The main and standby power supplies each consist of one Power Supply of series MI-31494. In addition, the repeater station with standby includes the following "common" equipment, which operates at all times whether main or standby radio equipment or power supply is in use: one Repeater Switchover Equipment MI-31021-B, -C, one Repeater Service Unit of series MI-31495, one Repeater Antenna Switching Unit MI-31029-B, and one Termination Unit, MI-31011 or MI-31056. At drop repeater stations, the common equipment also includes Baseband Unit MI-31493 or MI-31120.

Repeater Switching Unit MI-31021-B (figure 8) performs the function of switching the standby radio and/or standby power supply into operation at a repeater station in the event of an E-W or W-E radio (receiver or transmitter) and/or power supply fault. It contains the necessary relays and associated components for switching the input and output connections of each main equipment unit (except the "common" equipment) to an identical standby unit.

The standby radio equipment at a repeater standby station will be switched into operation when there is an appreciable decrease in transmitter r-f power output. The switchover is initiated by the transmitter fault sensing device, meter relay 1M2. This meter, in conjunction with crystal rectifier 1CR1, gives a relative indication of output power. When the power of the E-W transmitter, for example, falls to the point where the black needle of 1M2 comes in contact with the red needle, the relay contacts of 1M2 close and cause relay 6K1 in the repeater service unit to operate. Relay 6K1 closes contacts which (1) initiate the transmission of fault signals (2) provide for the inclusion of transmitter fault code in the fault signals, and (3) initiate immediate transfer to operation of the standby radio frequency equipment in place of the E-W equipment.

If the fault should occur in the W-E transmitter instead, the sequence of operation is similar, except that relay 6K10 operates instead of 6K1, and that the standby equipment operates in place of the W-E equipment.

After the faulty transmitter has been repaired, the E-W (or W-E) radio equipment can be restored to operation by pressing RESET button 9S6, on the repeater switching unit. Normal operation will then be restored within one minute.

If the IF amplifier of the E-W receiver/modulator should fail, a fault indication is sent to the repeater switching unit, and from there to the repeater service unit. In the switching unit, there is a delay of five seconds, intended to eliminate false switchover to standby due to transients. On completion of this delay, if the indication of a receiver fault still persists, switchover to operation of standby radio equipment in place of the E-W equipment takes place. In the service unit, the fault information operates relay 6K3, which initiates the transmission of receiver fault signals.

If the fault were in the IF amplifier of the W-E receiver/modulator, the resulting sequence is the same, except that the standby equipment will operate in place of the W-E equipment.

After the fault has been corrected, normal operation is restored within one minute after the RESET button is pressed. If the 2C39A tubes in the cold transmitter are old, the transmitter may be slow to build up power. If this happens, there is a possi-

bility that a transmitter fault will be indicated and the equipment will switch back to standby after about 55 seconds. If this occurs, the RESET button should be immediately pressed again, and normal operation will result.

The repeater switching unit contains three relays which sense faults in the main power supply. If any of the four output voltages (250 volts dc, 500 volts dc, ac unregulated, and ac regulated) of the power supply fail, immediate transfer to operation of the standby power supply will result. The repeater switching unit will send fault information to the repeater service unit, initiating the transmission of fault tones. A power supply fault or a receiver fault activates the same fault signaling circuit in the repeater service unit.

After the main power supply has been repaired, it can be restored to operation by pressing the RESET button.

Switchover to operation of standby radio equipment and standby power supply are completely independent of one another. When the RESET button is pressed, however, all main equipment will be restored to operation regardless of whether the standby radio equipment, the standby power supply or both have been operating.

CONTROLS

1. *LINE* switch, 9S1, is the power switch for the station. The power switches (5S1 and 5S2) in both main and standby power supplies should be left closed at all times, and 9S1 used as an "on-off" switch for the station.

2. *TEST-PWR* switch, 9S2, applies input power to both main and standby power supplies when switched to "TEST" with 9S1 closed. This feature is used in troubleshooting, as described in the section entitled "Maintenance."

3. *MAN. SWITCH TO STDBY-PWR SUP.* pushbutton, 9S5, initiates transfer to operation of the standby power supply. Fault tones (receiver code) are transmitted.

4. *MAN. SWITCH TO STDBY. E-W* pushbutton, 9S3, initiates transfer to operation of standby radio equipment in place of the E-W equipment. No fault tones are transmitted.

5. *MAN. SWITCH TO STDBY. W-E* pushbutton, 9S4, initiates transfer to operation of standby radio equipment in place of W-E equipment. No fault tones are transmitted.

6. *RESET* pushbutton 9S6 will restore to operation any main equipment (E-W, W-E, or main power supply) which has been switched out of operation in favor of standby equipment. If the restored equipment is incapable of satisfactory operation due to a fault, the standby equipment will again be automatically switched into operation within one minute.

FUNCTIONAL ANALYSIS

The following is a detailed description of the switchover operation at a repeater station with standby switching as performed by the Repeater Switchover Equipment, MI-31021-B. Refer to block diagrams of figures 9, 10 and 11 and the schematic diagram of figure 12 as aids in following this description.

1. Normal Steady-State Condition

This condition is reached by closing the LINE switch 9S1. Within one minute after this switch is closed, the repeater switching unit is prepared to perform its switchover functions when a fault occurs in the main station equipment. The following action ensues when switch 9S1 is closed:

a. Immediate Effects

Upon closure of the line switch, several different circuits are energized immediately. AC power is sent into the main power supply. From there it comes back to the switching unit, where it operates power supply fault sensing relays, 9K18 and 9K19, and lights E-W and W-E lamps 9I3 and 9I2. The ac power then goes to the E-W, W-E, and common equipment, as ac regulated and ac unregulated (filament and blower motor) power. In the power supply it also lights lamp 5I1 and energizes timer 5K3, which has a nominal delay of 30 seconds. Ac power is also sent to the antenna switching unit. It is there applied to the "normal" (corresponding to main radio equipment) coil inputs of the antenna relays.

The Repeater Antenna Switching Unit, MI-31029-B contains two antenna relays similar to the one described in the "Terminal Switchover Equipment" section. One operates on an E-W transfer to standby, and the other operates on a W-E switchover.

When the LINE switch 9S1 is closed, ac power is also applied to the LINE lamp 9I5, indicating the "Power On" condition. Power is also applied to motor-driven-timer 9K1. The purpose of this delay (0.9 minute) is to allow the main power supply and main transmitters to warm up before the associated fault circuits are enabled.

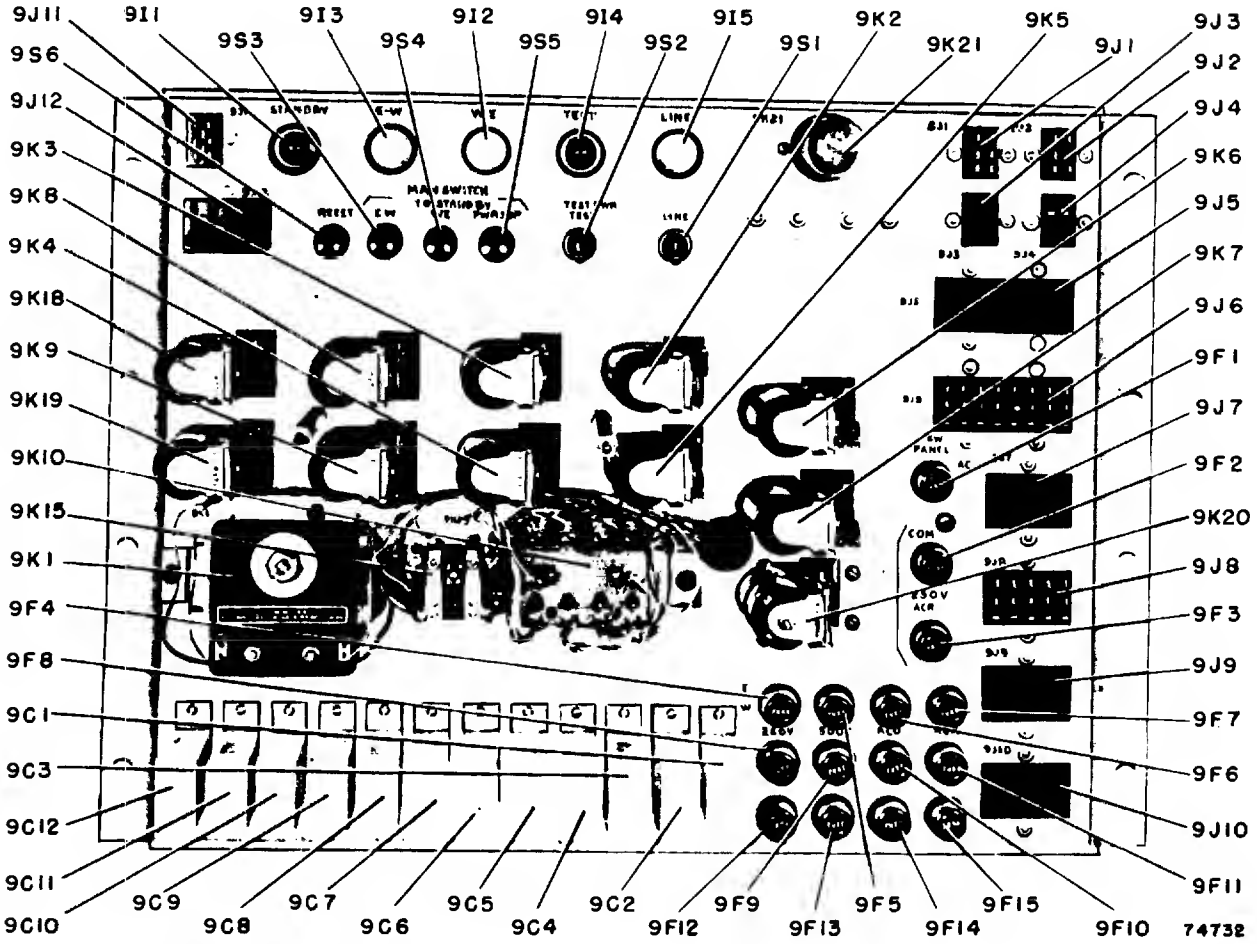


Figure 8—Repeater Switching Unit, MI-31021-B (front view)

b. 30 seconds after LINE switch 9S1 is closed

Timer 5K3 in the main power supply operates and supplies input ac to the high-voltage transformers of the 250 volt and 500 volt rectifiers. The dc output of these rectifiers is fed into the repeater switching unit, and from there to the E-W, W-E, and common equipment.

It will be noted from the schematic of figure 12 that each power connection to the E-W, W-E, standby, and common equipment from the switching unit is fused in the switching unit. If, for instance, a short-circuit develops in the E-W transmitter, a fuse will blow in the switching unit. The E-W equipment, with one of its input voltages removed, will indicate a fault and E-W switchover to operation of standby radio equipment will occur. If these switching unit fuses were not provided, a transmitter short circuit would blow a fuse in the main power supply, which would result in operation of the standby power supply and the subsequent blowing of its corresponding fuse.

c. 0.9 minute after LINE switch 9S1 is closed

Timer 9K1 completes its cycle and operates its contact (3-4-5) which in turn energizes 9K2 and 9K3. 9K2 and 9K3 operate, performing the following functions:

9K2 Operation

(1) Normally open contact 3-4 enables the W-E transmitter fault circuit.

(2) Normally open contact 5-6 enables the E-W transmitter fault circuit.

(3) Normally open contact 7-8 is not connected.

(4) Normally closed contact 9-10 releases 9K1, which re-cycles in approximately one second.

(5) Transfer contact 11-12-13 locks in 9K2 through the normally closed portion of transfer contact 11-12-13 of 9K4.

9K3 Operation

(1) **Transfer contact 3-4-5 is not connected.**

(2) Transfer contact 6-7-8 locks in 9K3 and enables the power supply fault circuit.

The switchover equipment has now reached its normal steady-state condition.

2. E-W Switchover to Operation of Standby Radio Equipment

The following is a description of the operation of switchover from the E-W radio equipment to the standby radio equipment.

The actual E-W switchover is accomplished by relays 9K6, 9K12, 9K13, 9K14, and the E-W antenna relay, regardless of the type of fault initiating the switchover. The last four of these relays are operated by contacts of 9K6; therefore, the fault sensing circuits must operate 9K6. The manner in which this is accomplished will be dealt with first, followed by a description of what 9K6 and its satellite relays do. In each case, normal steady-state initial conditions as described in the preceding paragraph under "0.9 minutes after Line switch 9S1 is closed" are assumed.

a. E-W Transmitter Fault

When the black needle of the r-f monitor 1M2 in the E-W transmitter falls and contacts the red needle, a ground circuit is connected which operates E-W transmitter fault relay 6K1 in the repeater service unit. The ground circuit goes through contacts 9K5-3-4-5 (which disables the transmitter fault circuit in the event of a receiver fault) and 9K2-5-6 (which disables the transmitter fault circuit during transmitter warmup and during power supply switchover). These contacts are both closed, however, since under normal steady-state conditions, 9K2 is operated (its normally open contact 5-6 is closed) and 9K5 is not operated (the normally closed part of its transfer contact 3-4-5 is closed).

When 6K1 operates, the contact designated "B" on the repeater service unit schematic (ID-24973) initiates the transmission of fault tones. Its "C" contact applies the transmitter fault code to the outgoing fault tones. The "A" contact of 6K1 feeds ac into the switching unit to operate 9K6, and thus initiate switchover.

b. E-W Receiver Fault

In the event of a fault in the E-W receiver/modulator 30 megacycle IF amplifier, relay 2K1 in the receiver/modulator operates, and relay 16K1 in the standby lockout unit (or relay 2K3, if the receiver/modulator is MI-31491-B) does not. The transfer contact 2K1-2-3-4 disables the main transmitter AFC motor, and operates baseband squelch relay 2K2. **Transfer contact 2-3-4 of 2K2 cuts off** the baseband and service channel outputs of the receiver/modulator. Transfer contact 5-6-7 of 2K2 sends ac through the normally closed part of the transfer contact 2-3-4 of 16K1 (or 2K3). This ac is then fed to the switching unit, where it operates relay 9K8. Transfer contact 9K8-3-4-5 operates relay 9K5 and energizes thermal timer 9K22. This timer provides a five second delay before switchover to prevent switchover due to transients. If the receiver fault indication disappears before completion of the delay, 9K8 is released, and it releases 9K5 and de-energizes 9K22.

Transfer contact 9K8-6-7-8 enables normally open contact 9K22-5-7 to operate 9K6 on the completion of the five second delay.

When relay 9K5 is operated by contact 9K8-3-4-5, transfer contact 9K5-3-4-5 and 9K5-12-13-14 disable the E-W and W-E transmitter fault circuits respectively. Contact 9K5-9-10-11 sends receiver fault information to the repeater service unit, where relay 6K3, which initiates the transmission of receiver fault tones, is operated. Contact 9K5-6-7-8 enables contact 9K6-18-19 to lock in 9K5 when switchover takes place. This is done so that relay 9K5 will remain operated (and resulting fault tones will be transmitted) after switchover, when 9K8 will release due to power being removed from the E-W receiver/modulator.

At the conclusion of its five second delay, 9K22 operates. Its contact 5-7 operates relay 9K6 through the now operated transfer contact 9K8-6-7-8.

c. Manual Switch to Standby E-W

If the MANUAL SWITCH TO STANDBY—E-W button is pressed, it operates relay 9K6, initiating switchover.

d. E-W Switchover—Functions of 9K6 and Satellites

When 9K6 operates, transfer contact 3-4-5 enables thermal timer 9K21 to apply "Relay Common" ac to the standby receiver/modulator after a 30 second delay. This delay prevents the standby transmitter AFC motor from running at random before the standby equipment is properly warmed up.

Transfer contact 9K6-6-7-8 operates the E-W antenna relay to its standby condition. Normally open contact 9K6-9-10 locks 9K6 in, and normally

closed contact 9K6-11-12 locks out 9K7, thus preventing any subsequent W-E switching. Transfer contact 9K6-13-14-15 switches the repeater service unit received service channel from the E-W to the standby receiver/modulator. Normally open contact 9K6-16-17 operates satellite relays 9K12, 9K13, and 9K14 while in case of a receiver/modulator fault only, normally open contact 9K6-18-19 locks 9K5 in through contact 9K5-6-7-8.

Relay 9K12 transfers the ac regulated and ac unregulated ouputs of the power supply from the E-W to the standby radio equipment. A power-type relay is used. Transfer contact 4-1-3 switches the ac unregulated, while contact 5-8-6 switches the ac regulated. The latter also applies power to STANDBY lamp 9I1 and to the heating element of thermal timer 9K21, which delays the activation of the standby transmitter AFC motor as described above.

The function of 9K13 is to transfer the 250 volt dc and 500 volt dc power from the E-W to the standby radio equipment. Since the transfer of such dc voltages at the currents used has a tendency to establish sustained arcs at the contacts, a power-type relay with double-break transfer contacts and resistance-capacitance arc-suppression networks is employed. Transfer contact 9K13-5-6-7-8 switches the 250 volt load, while 9K13-1-2-3-4 switches the 500 volt load.

Relay 9K14 transfers the baseband input and output from the E-W to the standby receiver/modulator. 9K14 contact 3-4-5 transfers the transmitted baseband, and contact 6-7-8 switches the received baseband.

3. W-E Switchover to Operation of Standby Radio Equipment

For a description of the W-E radio equipment switchover operation use the E-W radio equipment switchover description, starting at heading No. 2 on page 28 titled "E-W Switchover to Operation of Standby Radio Equipment," and substitute the corresponding W-E switching element from the following table. Whenever a reference is made to a component listed in the E-W column, substitute the component listed directly opposite in the W-E column. In this way the above description can be used to explain the W-E switchover operation by referring to the exact relays, contacts, switches and lamps actually involved in the W-E switchover operation. When a relay (for example 9K6) is listed in the E-W column, direct substitution of contacts as well as coil is indicated (for example, 9K7-3-4-5 for 9K6-3-4-5) unless otherwise indicated (for example, 9K17-6-7-8 for 9K14-3-4-5).

E-W	*W-E*
6K1	6K10
9K5-3-4-5	9K5-12-13-14
9K2-5-6	9K2-3-4
9K6	9K7
9K8	9K9
9K12	9K15
9K13	9K16
9K14	9K17
9K14-3-4-5	9K17-6-7-8
9K14-6-7-8	9K17-3-4-5
9I3	9I2
9S3	9S4

4. Switchover to Operation of Standby Power Supply

For switchover from main to standby power supply, normal steady-state condition of the switching unit is assumed.

a. Fault Sensing

Relays 9K18, 9K19, and 9K20 are the main ac power supply fault sensing relays. 9K18 is a 115 volt ac relay with its coil connected directly across the ac regulated output of the main power supply. It remains operated under normal conditions. If the ac regulated output of the main power supply fails, 9K18 releases transfer contacts 3-4-5 and 6-7-8. Contact 6-7-8 is not connected, but contact 3-4-5 operates 9K4, the master power supply switching relay and energizes 9K23 the transmitter fault re-disabling relay. It is this operating circuit of 9K4 and 9K23 that is kept open during the initial warmup by the power supply fault disabling contact 9K3-6-7-8.

Relay 9K19 performs exactly the same function as 9K18, except that its coil is connected across the ac unregulated output of the main power supply. Thus it monitors the blower motor power.

Relay 9K20 is a double-wound dc relay which monitors both the dc outputs of the main power supply. Each dc voltage is connected to one of the coils of this relay, through a resistor. The magnetic flux due to the two windings cancels when the two dc voltages maintain the proper ratio, and the relay does not operate. However, if one of the voltages should fall, so that the ratio gets outside specified limits, 9K20 will operate and close contact 5-6, which operates relay 9K4 and energizes 9K23.

MAN. SWITCH TO STDBY-PWR SUP button 9S5 is connected in parallel with the contacts of 9K18, 9K19 and 9K20. When it is pressed, 9K4 is operated, and 9K23 is energized and a transfer to operation of standby power supply is initiated.

b. Switchover—Functions of 9K4 and Satellites

1. 9K4 Operation

Transfer contact 9K4-11-12-13 operates satellite relays 9K10 and 9K11, the operation of which will be described under "9K10 and 9K11 Operation," and releases relay 9K2, in order to disable the transmitter fault circuits while power supply switching takes place and the standby power supply warms up. The action of relay 9K2 will be described under "Transmitter Fault Disabling." Normally closed contact 9K4-9-10 assures that relay 9K2 will not be re-operated until timer 9K1 has completed its delay cycle.

Normally open contact 9K4-3-4 sends fault information to the repeater service unit, where it operates 6K3. The contacts of 6K3 initiate transmission of receiver fault tones.

Normally open contacts 9K4-5-6 and 9K4-7-8 are not connected.

2. 9K10 and 9K11 Operation

9K10 is a power-type relay which transfers the ac line from the input of the main power supply to that of the standby power supply, and also transfers the ac regulated and ac unregulated loads from main to standby power supply. Contact 2-13-1 switches the input ac high, contact 4-12-3 switches the input ac common, contact 8-10-7 switches the ac regulated load, and contact 6-11-5 switches the ac unregulated load.

9K11 is a double-break relay similar to 9K13, which was described under "Switchover to Operation of Standby Radio Equipment—Functions of 9K6 and Satellites." It also has similar arc-suppression networks. Its function is to transfer the 250 volt dc and 500 volt dc loads from the main power supply to the standby power supply. Contact 1-2-3-4 switches the 500 volt load, while contact 5-6-7-8 switches the 250 volt load.

3. Transmitter Fault Disabling

During the period of power supply switchover and of standby power supply warmup, it is necessary to disable the E-W and W-E transmitter fault circuits. With no dc voltage input to the transmitters, the fault contacts of 1M2 will be closed. With no dc voltage, the transmitter fault relays 6K1 and 6K10 in the repeater service unit cannot operate. However, when the dc voltages are applied, if no disabling were used 6K1 and 6K10 would operate before the transmitter fault contacts of 1M2 are broken, and a switchover to operation of standby radio equipment would take place. Therefore, disabling of the transmitter fault circuits is necessary.

To accomplish this, advantage is taken of the 9K1-9K2 disabling cycle used when the equipment is originally energized (see section entitled "Normal Steady-State Condition").

As mentioned under "9K4 Operation," contact 9K4-11-12-13 releases 9K2. Normally open contact 9K2-7-8 is not connected. Normally open contacts 9K2-3-4 and 9K2-5-6 disable the W-E and E-W transmitter fault circuits respectively. Normally closed contact 9K2-9-10 energizes timer 9K1, and transfer contact 9K2-11-12-13 in conjunction with the now open contact 9K4-9-10 assures that relay 9K2 cannot be re-operated until timer 9K1 completes its delay cycle. Since the coil of 9K2 has been broken by contact 9K4-11-12-13, an alternate circuit is provided after a delay of 5 seconds by contact 5-7 of 9K23. Relay 9K23 thermal timer with a 5 second delay, the function of which is to enable relay 9K2 to be reoperated (the transmitter fault circuits re-enabled) when timer 9K1 completes its delay cycle.

After a delay of 0.9 minutes, 9K1 operates, and its contact 3-4-5 operates 9K2 through 9K23-5-7.

Contacts 9K2-3-4 and 9K2-5-6 close again, re-enabling the transmitter fault circuits. Contact 9K2-9-10 opens, releasing 9K1, and transfer contact 9K2-11-12-13 locks in 9K2, through 9K23-5-7.

5. Resetting to Operation of Main Radio and Power Supply Equipment

By pressing the RESET button 9S6 the main radio equipment or power supply or both will be switched back into operation and will stay in operation if the fault in the main equipment has been repaired.

When RESET button 9S6 is pressed, directly or indirectly it releases any operated relays in the repeater switching unit with the exception of power supply monitor relays 9K18, 9K19 and 9K20; receiver fault relays 9K8 and 9K9, and timer 9K1. Relay 9K6 (or 9K7, if the W-E equipment was out of operation), in releasing, operates the E-W (or W-E) antenna relay to its "normal" condition. Relay 9K2, in releasing, disables the transmitter fault circuits and starts timer 9K1 on its delay cycle. Relay 9K3 in releasing, disables the power supply fault circuit.

When 9K2 releases and 9K1 is energized, the conditions, insofar as the switching unit is concerned, are the same as those that prevail just after the initial closing of LINE switch 9S1. The sequence of operations which follow within the switching unit is described under "Normal Steady-State Condition."

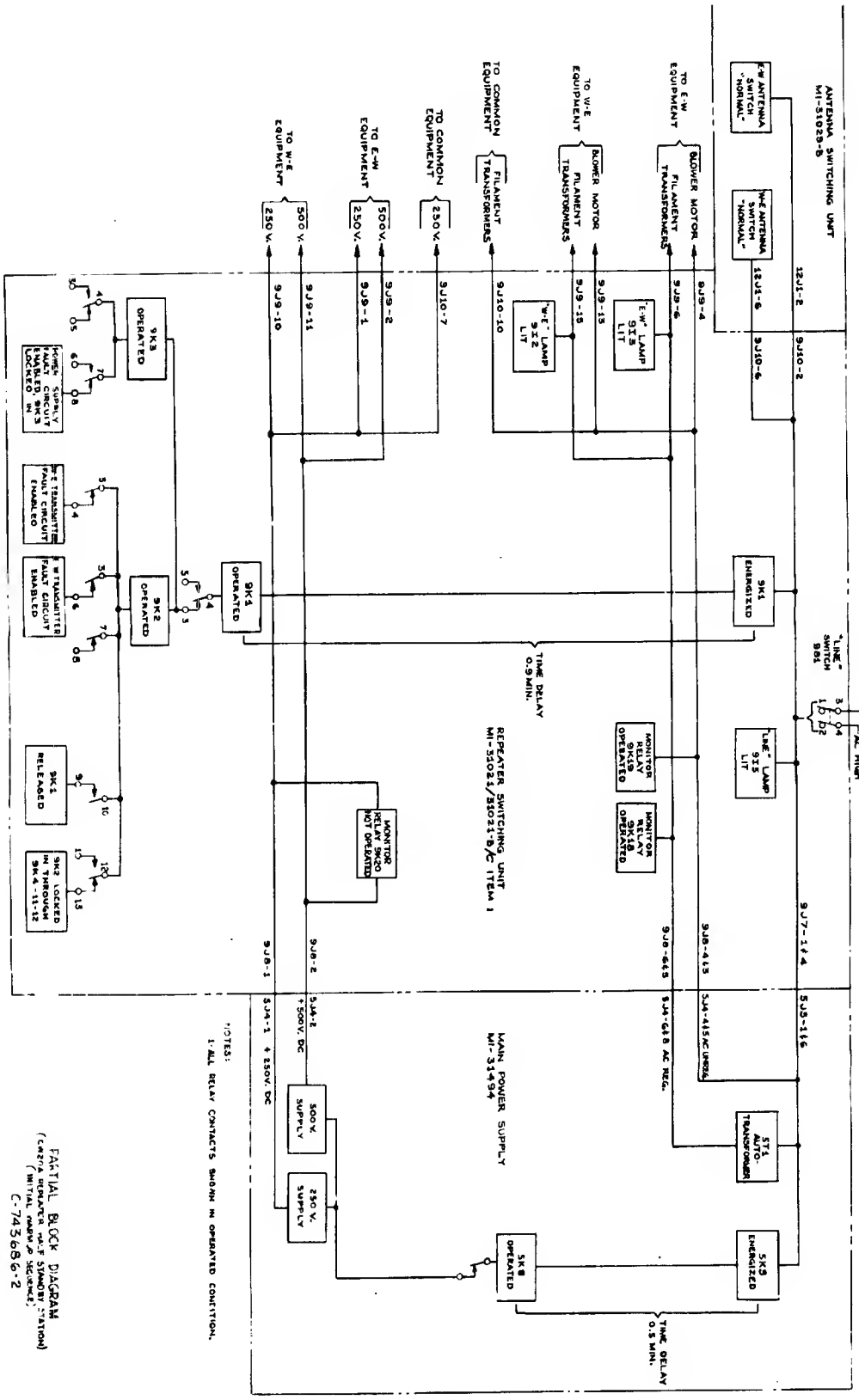
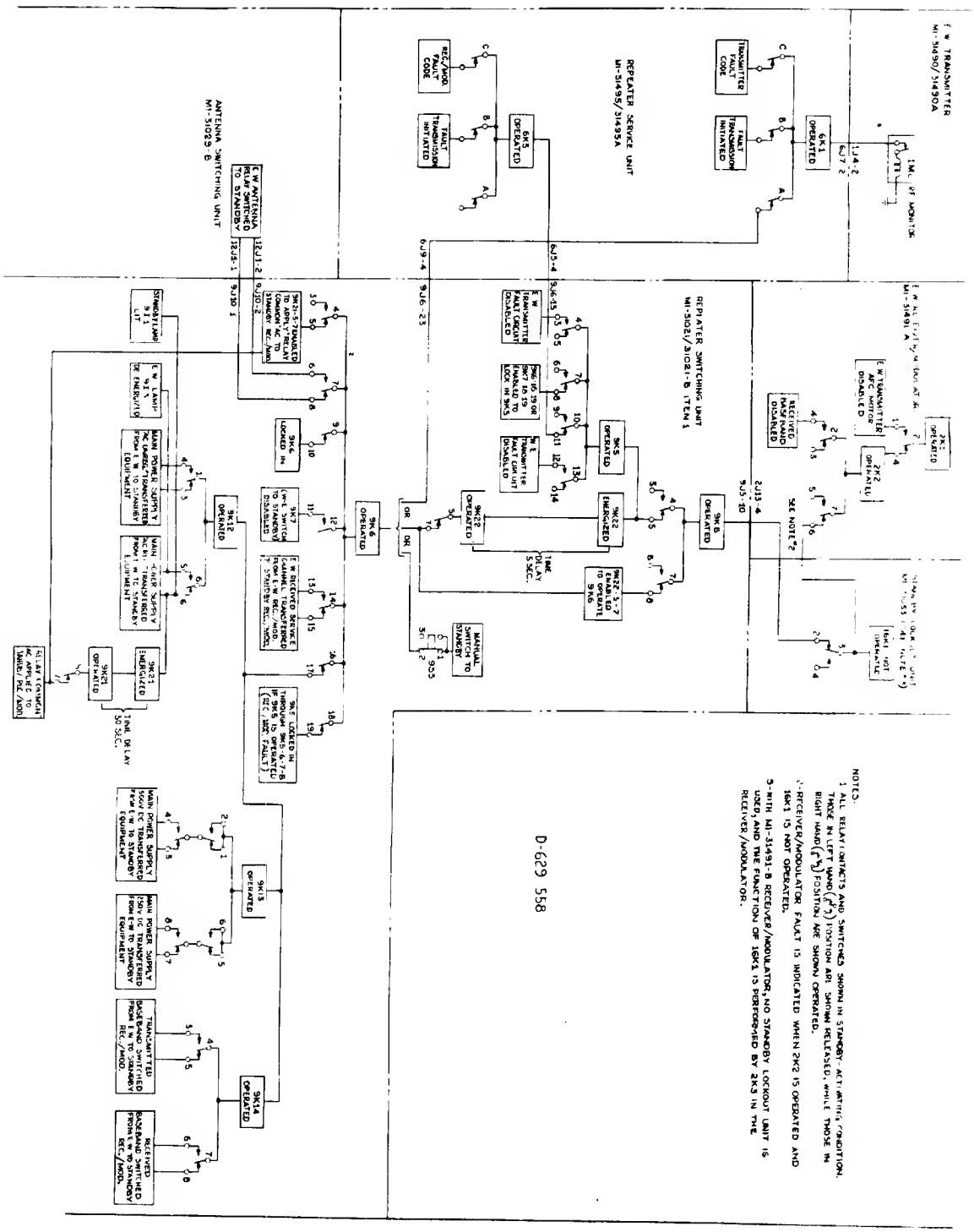


Figure 9—Repeater Standby Station Warm-up Sequence—Block Diagram



NOTES:

1. ALL RELAY CONTACTS AND SWITCHES SHOWN IN STANDBY-ACTIVATING CONDITION. THOSE IN LEFT HAND (E-W) POSITION ARE SHOWN RELEASED, WHILE THOSE IN RIGHT HAND (E-W) POSITION ARE SHOWN OPERATED.
2. RECEIVER/MODULATOR FAULT IS INDICATED WHEN 2K2 IS OPERATED AND 16K1 IS NOT OPERATED.
3. WITH MI-31491-B RECEIVER/MODULATOR, NO STANDBY LOCKOUT UNIT IS USED, AND THE FUNCTION OF 16K1 IS PERFORMED BY 2K3 IN THE RECEIVER/MODULATOR.

Figure 10—Repeater Standby Station Radio Equipment Changeover Sequence—Block Diagram

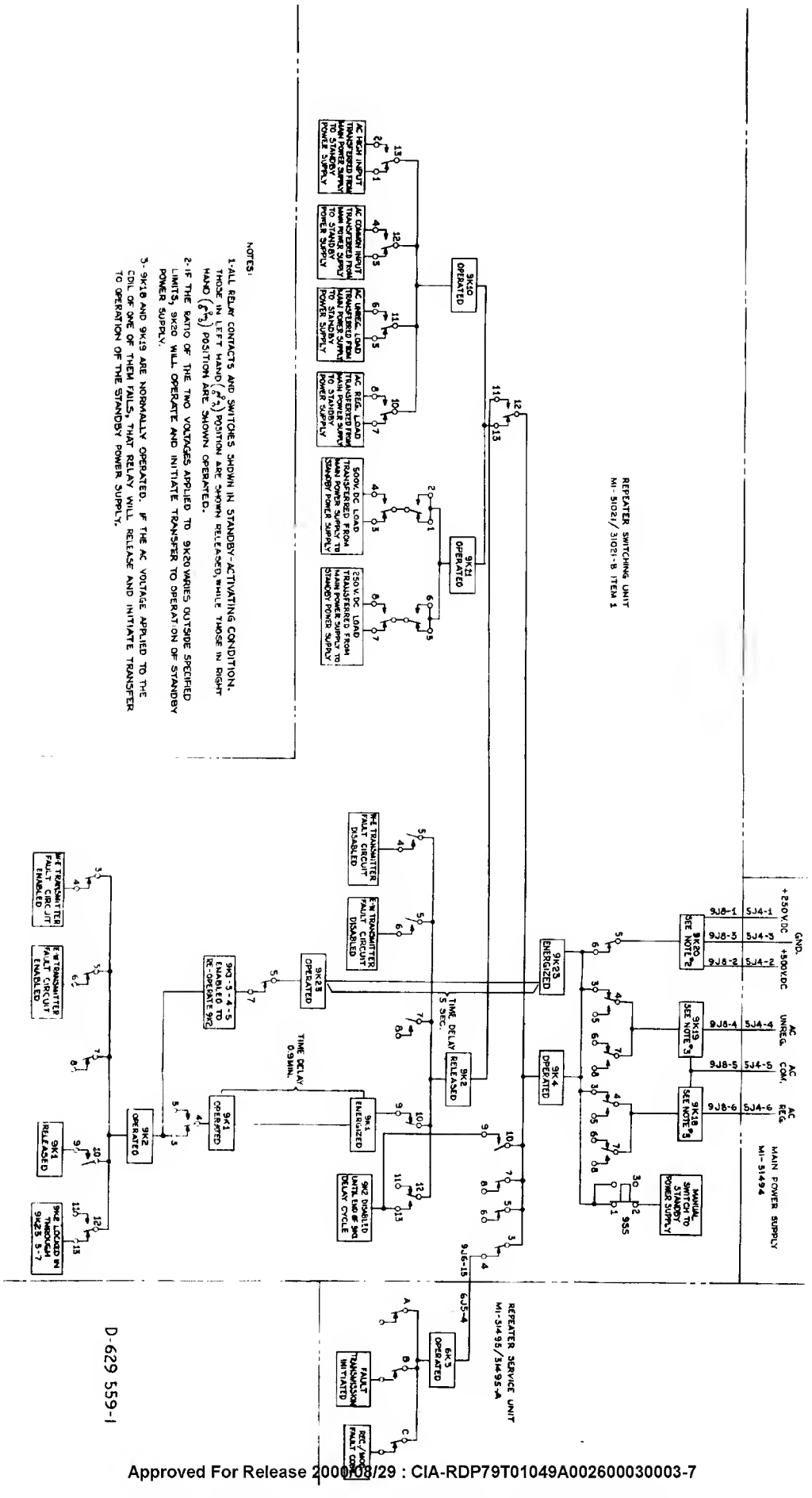


Figure 11—Repeater Standby Station Power Supply Changeover Sequence—Block Diagram

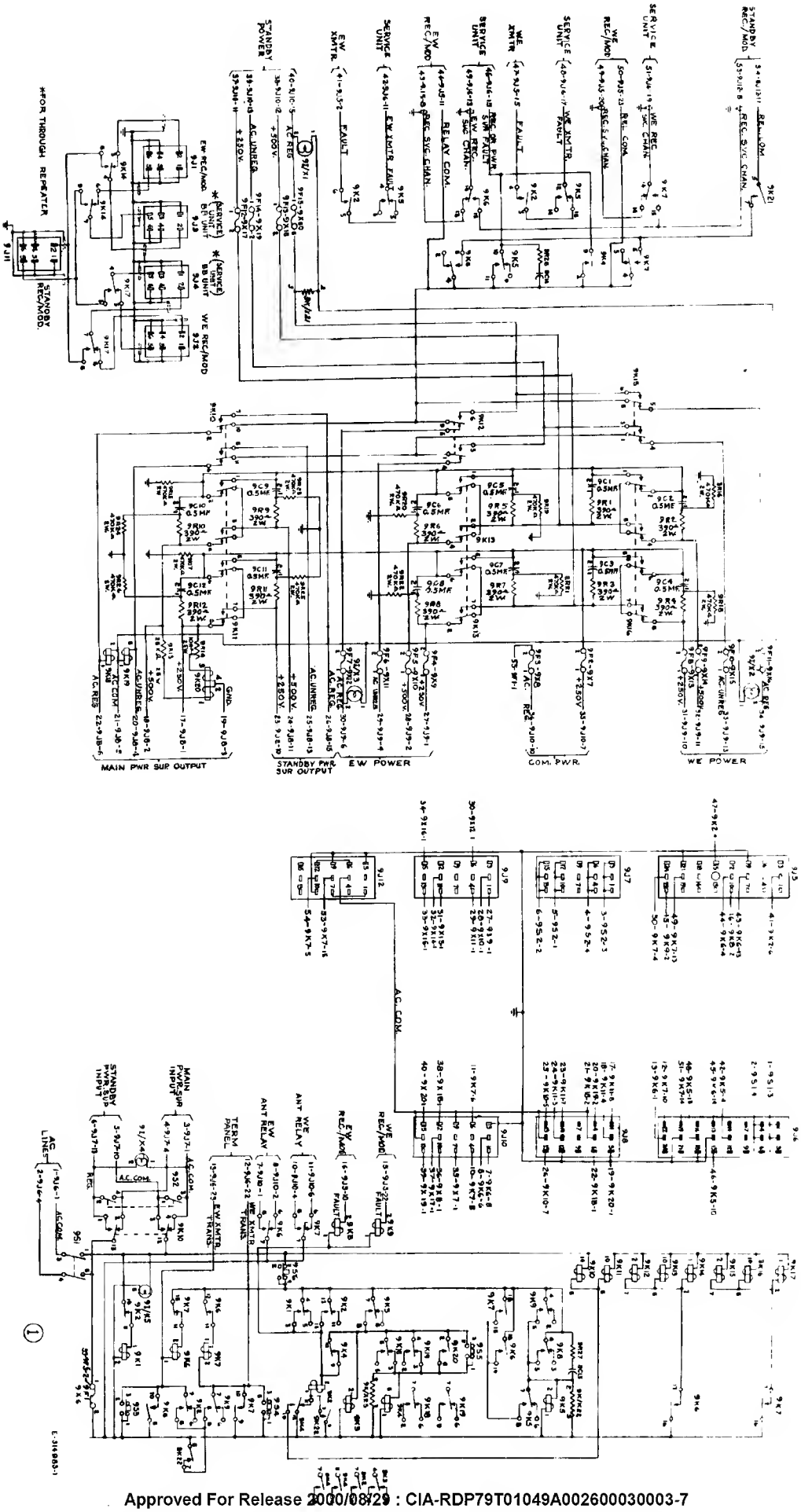


Figure 12—Repeater Switching Unit, MI-31021-B—Schematic Diagram

REPEATER ANTENNA SWITCHING UNIT MI-31029-B

Repeater Antenna Switching Unit MI-31029-B is a rack mounting unit installed in the topmost position in the standby equipment rack. It contains two relays, E-W and W-E, each with two coaxial switching sections. The E-W (W-E) relay switches the antenna connections from the E-W (W-E) radio equipment to the standby radio equipment when the standby radio equipment is switched into operation in place of the E-W (W-E) radio equipment by an E-W (W-E) transmitter or receiver fault. One section of the E-W (W-E) relay switches the connections to the E-W (W-E) transmitter filter from the E-W (W-E) transmitter to the standby transmitter. The other section of the E-W (W-E) relay switches the connection to the E-W (W-E) receiver filter from the E-W (W-E) receiver to the standby receiver. The relays are of the type which remove the energizing voltage immediately after the relay is operated. When operated, it is mechanically latched, and remains operated until its "release" coil is energized.

These relays are controlled by the action of the two master radio equipment switching relays 9K6 and 9K7, the E-W and W-E master switchover relays respectively. When an E-W or W-E radio equipment failure operates relay 9K6 or 9K7, contact 6-7-8 applies ac to the antenna switching relay "standby" (operate) coil. For an E-W radio equipment failure, 9K6-6-7-8 switches the West antenna transmitter connection from the E-W transmitter to the standby transmitter and the East antenna receiver connection from the E-W receiver to the standby receiver. For a W-E radio equipment failure, 9K7-6-7-8 switches the East antenna transmitter connection from the W-E transmitter to the standby receiver and the West antenna receiver connection from the W-E receiver to the standby receiver. With the fault repaired and RESET button 9S6 pressed, 9K6 or 9K7 is released and contact 6-7-8 applies ac to the "normal" (release) relay coil changing the antenna connections from the standby radio equipment to the main E-W or W-E radio equipment.

STANDBY LOCKOUT CIRCUIT

At a standby switching station, some method must be provided so that the standby radio equipment will not be switched into operation due to a cessation of the incoming microwave signal but will occur only when the receiver IF amplifier actually fails to function. The standby lockout circuit of the receiver/modulator unit provides this facility at all installations. In receiver/modulator MI-31491-B, this function is included as an integral part of the unit. For MI-31491-A this circuit is obtained by the installation of Standby Lockout Unit, MI-31055. The purpose of the lockout circuit is to prevent a switchover from the main to the standby radio equipment when the rf signal fails and the receiver is operating normally, but allows a switchover if trouble develops in the receiver IF stages.

FUNCTIONAL ANALYSIS

In the ensuing description all reference to components in the standby lockout circuit will be by symbol numbers shown on the receiver/modulator schematic of figure 14. Figure 13 is the schematic of the Standby Lockout Unit MI-31055.

The standby lockout circuit consists of several stages of audio (noise voltage) amplification 2V17-1-2-3, 2V17-6-7-8 and 2V18-1-2-3, a crystal rectifier 2CR7, a dc amplifier 2V18-6-7-8 and a dc relay 2K3.

The "NOISE GAIN" potentiometer 2R115 is a control for regulating the amount of noise signal to amplifier 2V17-6-7-8. The "OPR CUR" jack 2J15 monitors the operating current of the dc amplifier 2V18-6-7-8, and is used when adjusting the "NOISE GAIN" control.

The 115 v ac standby switching circuit in the receiver is controlled by transfer contact 5-6-7 of audio squelch relay 2K2 and transfer contact 2-3-4 of lockout relay 2K3. Relay 2K2 is controlled by fault circuit relay 2K1 and relay 2K3 is controlled by the standby lockout circuit. Contact 6-7 of relay 2K2 and contact, 2-3 of relay 2K3 must be closed at the same time to cause the 115 ac standby switching circuit to be completed through to the switching unit to initiate switchover of the standby radio equipment. This means that relays 2K1 and 2K2 must be operated and relay 2K3 not operated to initiate switchover.

The action of the lockout circuit is controlled by the voltage present at the junction of resistors 2R21 and 2R127 or for reference purposes at the more easily identified SIG jack 2J4.

A strong saturating signal at the receiver input results in a dc voltage at 2J4 by the action of diode rectifier 2CR2, and limiting of the noise voltage due to saturation of IF stage 2V5. DC blocking

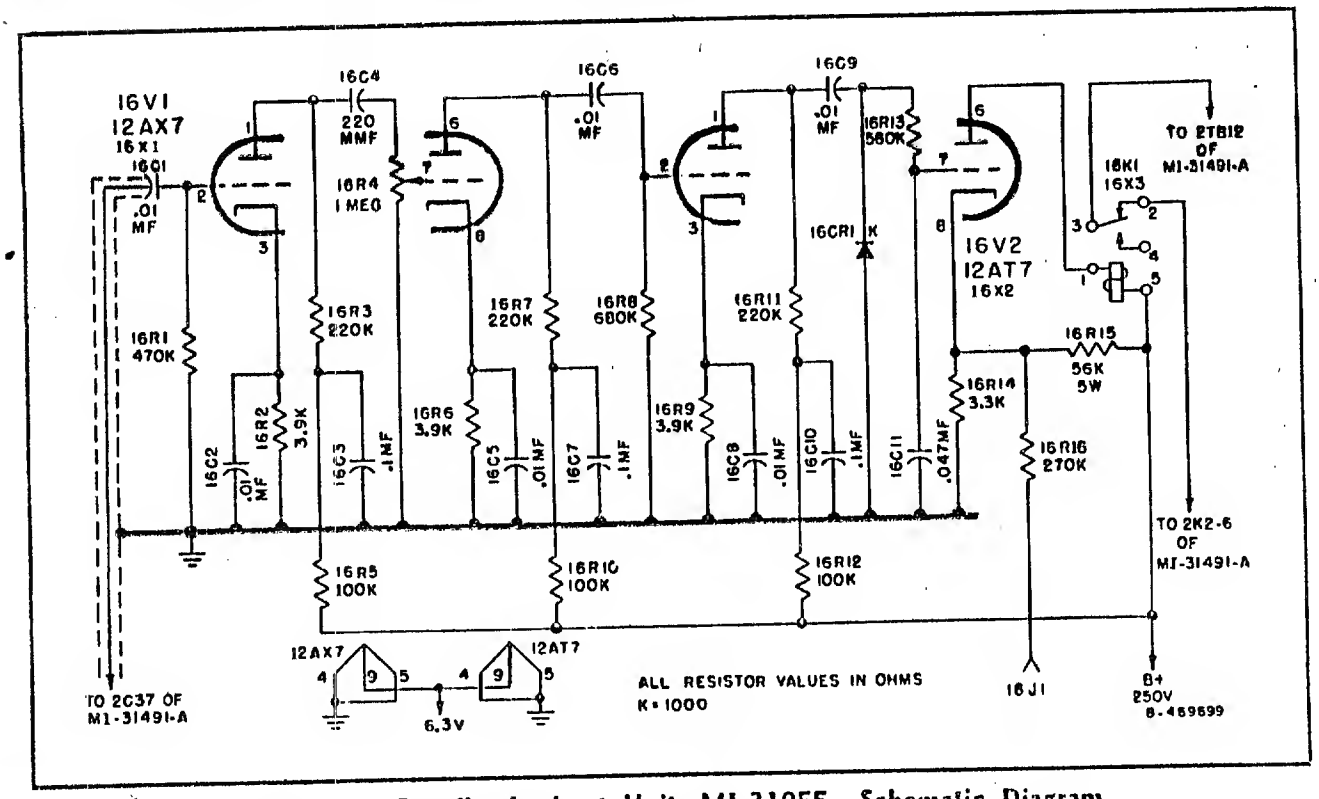


Figure 13—Standby Lockout Unit, MI-31055—Schematic Diagram

capacitor 2C115 prevents the dc voltage from being applied to the grid of the 1-2-3 section of amplifier 2V17. The lockout stages remain static and relay contact 2-3 of 2K3 stays closed. However, a saturating signal holds fault relay 2K1 open causing relay 2K2 to remain open thereby breaking the standby switching circuit.

A no-signal normal-operation condition in the receiver IF strip results in a drop in the dc voltage sufficient to operate relays 2K1 and 2K2 and in an ac noise voltage at 2J4. This noise voltage is impressed on 2V17-2, amplified through three audio stages, rectified by diode 2CR7 and impressed on the grid of dc amplifier 2V18-6-7-8. The resultant plate current flow operates lockout relay 2K3. Contact 2-3 of 2K3 opens and breaks the 115 v ac standby switching circuit thereby preventing switchover to standby operation.

When the receiver IF amplifier fails to function normally, the dc voltage present at 2J4 drops to zero causing relay 2K1 to operate relay 2K2 and close contact 6-7. Any noise voltage present at 2J4 is too weak to activate the standby lockout circuit so relay contact 2-3 of 2K3 is closed. The standby switching contacts of both relays 2K2 and 2K3 are now closed. This condition completes the 115 v ac standby switching circuit to operate relay 10K7 of the terminal switching unit or to relays 9K6 or 9K7 of the repeater switching unit thereby switching the station to standby operation, after a short time delay.

INSTALLATION

To install a microwave station complete with standby equipment use the installation instructions of the basic equipment in conjunction with the following information:

Terminal Standby Station

For a terminal station with standby, two racks are required, located directly adjacent to one another. As viewed from the front, the right-hand rack will contain the main equipment and the common equipment with the exception of the terminal switching unit, while the left-hand rack will contain the terminal switching unit and the standby equipment. The two racks are connected together by the large standby cable, MI-31022-A, -B item 3. The equipment layout and all cable connections are shown in figure 22.

To add standby to an existing terminal station, remove from the terminal equipment all MI-31499

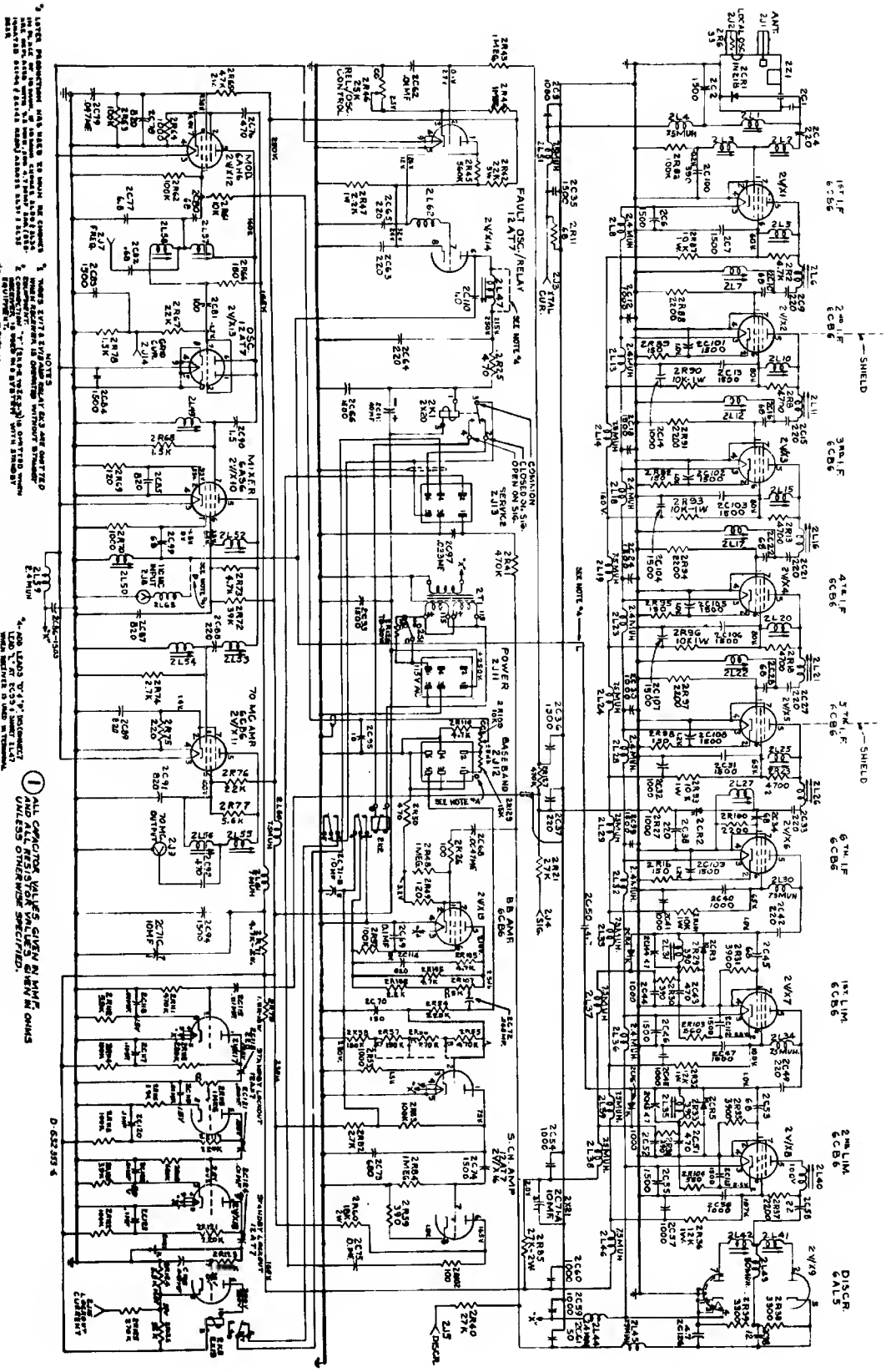


Figure 14—Receiver/Modulator, MI-31491-B—Schematic Diagram

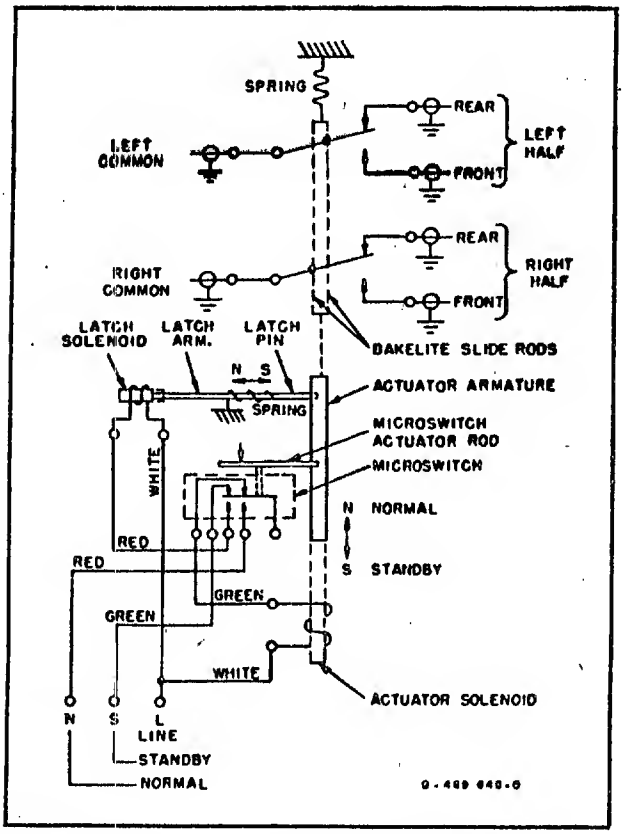


Figure 15—Antenna Switching Unit Coaxial Switch—Schematic Diagram

cables except the MI-31499-B25 cable connected from 4J1 of the baseband unit to 2J12 of the receiver/modulator. This cable will remain, connected as it is, in the standby installation. Remove all MI-31031 rf cables from the terminal equipment. Mount the terminal antenna switching unit as shown in figure 22. When the standby rack is installed, with all units in place, the cables to the two racks should be connected in accordance with the cabling in figure 22. In connecting these cables, caution should be exercised to insure correct connections, or damage to equipment may result when power is applied. The plugs of cable MI-31022-A, -B item 3 are stenciled with the schematic symbol numbers of the panel plugs which receive them.

If MI-31491-A receiver/modulators are used, standby lockout units, MI-31055 must be attached (see section entitled "Standby Lockout Operation").

Repeater Standby Station

For a repeater station with standby, two racks are required, located directly adjacent to one another. As viewed from the front, the right-hand rack will contain the main equipment (E-W, W-E and power supply) and the common equipment with the exception of the repeater switching unit and the repeater antenna switching unit, MI-31029-B. The left-hand rack will contain the repeater switching unit, the repeater antenna switching unit, and the standby equipment. The two racks are connected together by the large standby cable, MI-31021/31021-B item 2. Equipment layout and all cable connections are shown in figure 27.

To add standby to an existing drop-repeater station, remove from the repeater all MI-31499 cables except the MI-31499-A22 cable connected from 4J3 of the base-band unit to 6J8 of the repeater service unit. This cable will remain, connected as it is, in the standby installation. If standby is being added to a thru repeater, remove all MI-31499 cables. In either case, remove all MI-31031 rf cables from the repeater. When the standby rack is installed, with all units in place, the cables to the

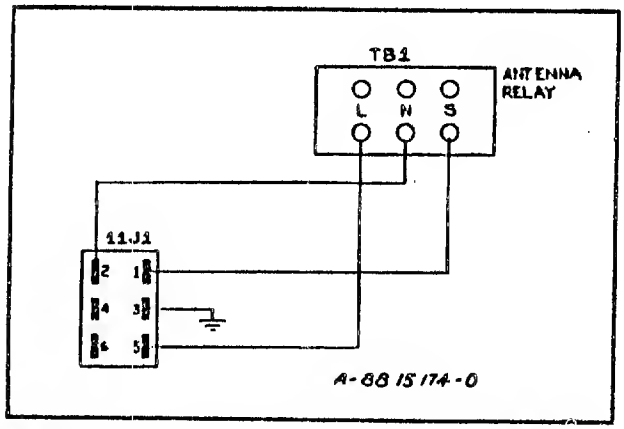


Figure 16—Terminal Antenna Switching Unit, MI-31022-B, Item 2—Schematic Diagram

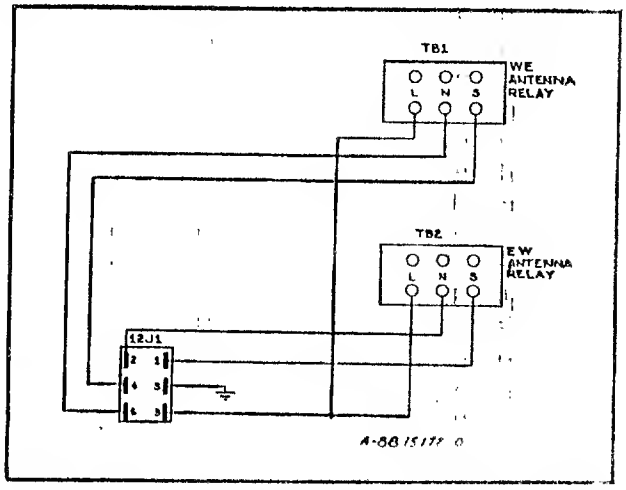


Figure 17—Repeater Antenna Switching Unit, MI-31029-B—Schematic Diagram

two racks should be connected in accordance with the cabling in figure 27. In connecting these cables, caution should be exercised to insure correct connections, or damage to equipment may result when power is applied. The plugs of cable MI-31021/31021-B item 2 are stenciled with the schematic symbol numbers of the panel plugs which receive them.

If MI-31491-A receiver/modulators are used, standby lockout units MI-31055 must be attached (see section entitled "Standby Lockout Operation").

MI-31055 Standby Lockout Unit

An MI-31055 Standby Lockout Unit should be installed in each MI-31491-A receiver/modulator before it is used at any station equipped with standby switchover facilities. Direction for installing MI-31055 in MI-31491-A are supplied with the standby lockout unit. When properly installed the unit may be loosened and pulled far enough away from the chassis to permit trouble shooting without unsoldering the interconnecting leads.

INITIAL ADJUSTMENTS

To prepare a CW-20A (MM-20A) standby switchover station for operation, perform the following adjustments in the order in which they are listed below:

Terminal Standby Station

1. Remove fuse 10F1, SW PANEL AC, from the terminal switching unit. This disables the switching unit and prevents undesired switchover to standby operation while adjustments are being made.

2. With all power supply switches off, close LINE switch 10S1 on the terminal switching unit.

3. Turn the main transmitter meter switch to 250. Close LINE switch 5S1 on the main power supply. The power supply pilot lamp, 5I1, and switching unit LINE lamp, 10I4, should light. Carefully measure the elapsed time between the closing of 5S1 and the appearance of a finite (roughly one-fourth scale) reading on transmitter meter 1M1. This gives a measurement of the high voltage delay in the main power supply. It should be between 25 and 35 seconds.

4. Turn off the LINE switch 5S1, of the main power supply.

5. Follow the procedure outlined in the basic equipment instruction books under "Initial Adjustments—Terminal Station Tuning."

6. Check the operation of the standby lockout unit associated with the main receiver/modulator and adjust its potentiometer as described in the section entitled "Standby Lockout Circuit Section." This procedure will apply directly to the receiver/modulator if it is MI-31491-B.

7. Re-insert fuse 10F1 and press MAN. SW. TO STDBY.–PWR. SUP. button 10S4. All voltages will be removed from the radio equipment at once, since switchover to operation of standby power supply will take place, but the switches on the standby power supply are open.

8. Press MAN. SW. TO STDBY.-TERM. button 10S3. Immediate switchover to operation of standby radio equipment will occur. The station is now ready for operation of the standby radio equipment from the standby power supply.

9. Repeat step 3, using the standby transmitter meter 1M1 and the standby power supply.

10. Turn the LINE switch, 5S1, of the standby power supply off.

11. Using the standby power supply and standby radio equipment, follow the procedure outlined in the basic equipment instruction books under "Initial Adjustments-Terminal Station Tuning." Omit step 20, service unit level adjustments.

12. Turn off the LINE switch 10S1 on the terminal switching unit. With all power off, see that timer 10K1 is set for a delay of 0.9 minute, and that timer 10K7 is set for a delay of 0.1 minute. Replace the switching unit dust covers and close LINE switch 10S1. After the tubes warm up (about one minute), the main radio equipment will be operating normally from the main power supply.

13. Make certain that the TERMINAL FAULTS switch 7S5, in the terminal service unit is closed (in the upper position).

14. After at least one minute, advance the red needle of the main transmitter rf monitor meter 1M2, until it contacts the black needle. Immediate switchover to operation of the standby radio equipment from the main power supply will occur. The "T" lamp on the terminal service unit should

light. Return the red needle of 1M2 to its original setting.

15. Turn off the TRANS TUNE switch 5S2 on the main power supply. Immediate power supply switchover will occur, so that after the 30 second power supply warmup delay, the standby radio equipment will be operating from the standby power supply. Turn on the TRANS TUNE switch 5S2 on the main power supply and press RESET button 10S5 on the terminal switching unit. Operation of all main equipment will be restored.

16. After waiting one minute, remove the E-W 250 v. fuse, 5F15, from the main power supply. Switchover to operation from the standby power supply will occur at once. Replace 5F15.

17. Wait one minute, then pull 2V1, the first IF tube, from the main receiver/modulator. After a delay of about 6 seconds, switchover to operation of standby radio equipment will take place. If it does not, recheck the setting of the main receiver/modulator "REL OSC" and "NOISE GAIN" controls. Replace 2V1, and press RESET button, 10S5. Operation of all main equipment will be restored.

18. After one minute, remove the EW AC REG fuse 5F17 from the main power supply. See that a power supply switchover occurs with no radio equipment switchover. Replace 5F17 and press RESET button 10S5. Operation of all main equipment will be restored.

19. After one minute, remove the EW AC UNREG fuse 5F18 from the main power supply. See that a power supply switchover occurs with no radio equipment switchover. Replace 5F18 and press RESET button 10S5. Operation of all main equipment will be restored.

20. With the main transmitter tuned for maximun output as indicated on monitor meter 1M2, adjust this reading to 150 μa by means of MONITOR ADJUST control 1R14. A suggested setting for the red needle of 1M2 is 50 μa, but in individual cases experience may show a better value.

Repeater Standby Station

1. Remove fuse 9F1, SW PANEL AC, from the repeater switching unit. This disables the switching unit and prevents undesired switchover to standby operation while adjustments are being made.

2. With all power supply switches off, close LINE switch 9S1 on the repeater switching unit.

3. Turn the E-W transmitter meter switch to 250. Close LINE switch 5S1 on the main power supply. The power supply pilot lamp, 5I1, should light. Carefully measure the elapsed time between the closing of 5S1 and the appearance of a finite (roughly one-fourth scale) reading on E-W transmitter meter 1M1. This gives a measurement of the high voltage delay in the main power supply. It should be between 25 and 35 seconds.

4. Turn off the LINE switch, 5S1, of the main power supply.

5. Follow the procedure outlined in the basic equipment instruction books under "Initial Adjustments—Repeater Station Tuning."

6. Check the operation of the standby lockout unit associated with the E-W and W-E receiver/modulators and adjust their Noise Gain potentiometers as described in the "Standby Lockout Circuit" section. This procedure will apply directly to the receiver/modulators if they are MI-31491-B.

7. Re-insert fuse 9F1 and press MAN. SWITCH TO STANDBY-PWR SUP button 9S5. All voltages will be removed from the main radio equipment at once, since switchover to operation of standby power supply will take place, but the switches on the standby power supply are open.

8. Press MAN. SWITCH TO STDBY-E-W button 9S3. Immediate E-W switchover will occur. The station is now ready for operation of the standby radio equipment, and the W-E equipment from the standby power supply.

9. Repeat step 3, using the standby transmitter meter 1M1 and the standby power supply.

10. Turn the LINE switch, 5S1, of the standby power supply off.

11. Using the standby power supply and standby radio equipment, follow the procedure outlined in the basic equipment instruction books under "Initial Adjustments-Repeater Station Tuning." Omit step 23, service unit level adjustments.

12. Turn off LINE switch 9S1 on the repeater switching unit. With all power off, see that timer 9K1 is set for a delay of 0.9 minute. Replace switching unit dust covers and close LINE switch 9S1. After the tubes warm up (about one minute), the E-W and W-E radio equipment should be operating normally from the main power supply.

13. After at least one minute, advance the red needle of the E-W transmitter RF monitor meter 1M2, until it contacts the black needle. Immediate switchover to operation of the standby radio equipment in place of the E-W equipment will occur. Transmitter Fault tones will be transmitted. Return the red needle of 1M2 to its original setting.

14. Press RESET button 9S6. Repeat step 13, using the W-E transmitter monitor meter. The standby radio equipment will operate in place of the W-E equipment.

15. Turn off the TRANS TUNE switch 5S2 on the main power supply. Immediate power supply switchover will occur, so that after the 30 second power supply warmup delay, the standby radio equipment and the E-W equipment will be operating from the standby power supply. Turn on the TRANS TUNE switch 5S2 on the main power supply and press RESET button 9S6 on the terminal switching unit. Operation of all main equipment will be restored.

16. After waiting one minute, remove E-W 250 v. fuse, 5F15, from the main power supply. Switchover to operation from the standby power supply will occur at once. Replace 5F15.

17. Wait one minute, then pull 2V1, the first IF-tube, from the E-W receiver/modulator. After a delay of about 5 seconds, switchover to operation of standby radio equipment in place of the E-W equipment will occur. If it does not, recheck the setting of the "REL OSC" and "NOISE GAIN" controls in the E-W receiver/modulator. Replace 2V1, and press RESET button, 9S6. Operation of all main equipment will be restored.

18. Repeat step 17, pulling IF tube 2V1 from the W-E receiver. The standby equipment will operate in place of the W-E equipment.

19. After one minute, remove the E-W AC REG fuse 5F17 from the main power supply. See that a power supply switchover occurs with no radio equipment switchover. Replace 5F17 and press RESET button 9S6. Operation of all main equipment will be restored.

20. After one minute, remove the E-W AC UNREG fuse 5F18 from the main power supply. See that a power supply switchover occurs with no radio equipment switchover. Replace 5F18 and press RESET button 9S6. Operation of all main equipment will be restored.

21. With both main transmitters tuned for maximum output as indicated on monitor meter 1M2, adjust this reading to 150 μa in each transmitter by means of MONITOR ADJUST control

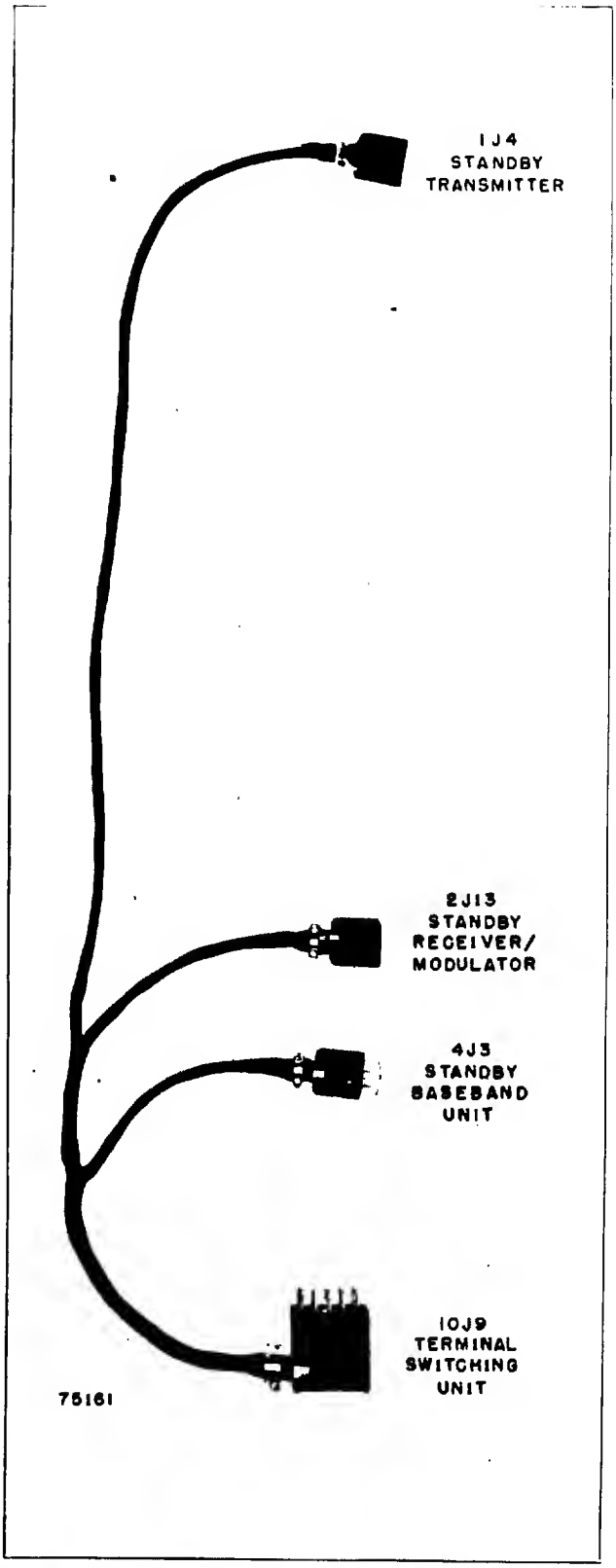


Figure 18—Terminal Standby Rack Connecting Cable, MI-31022-B, Item 4

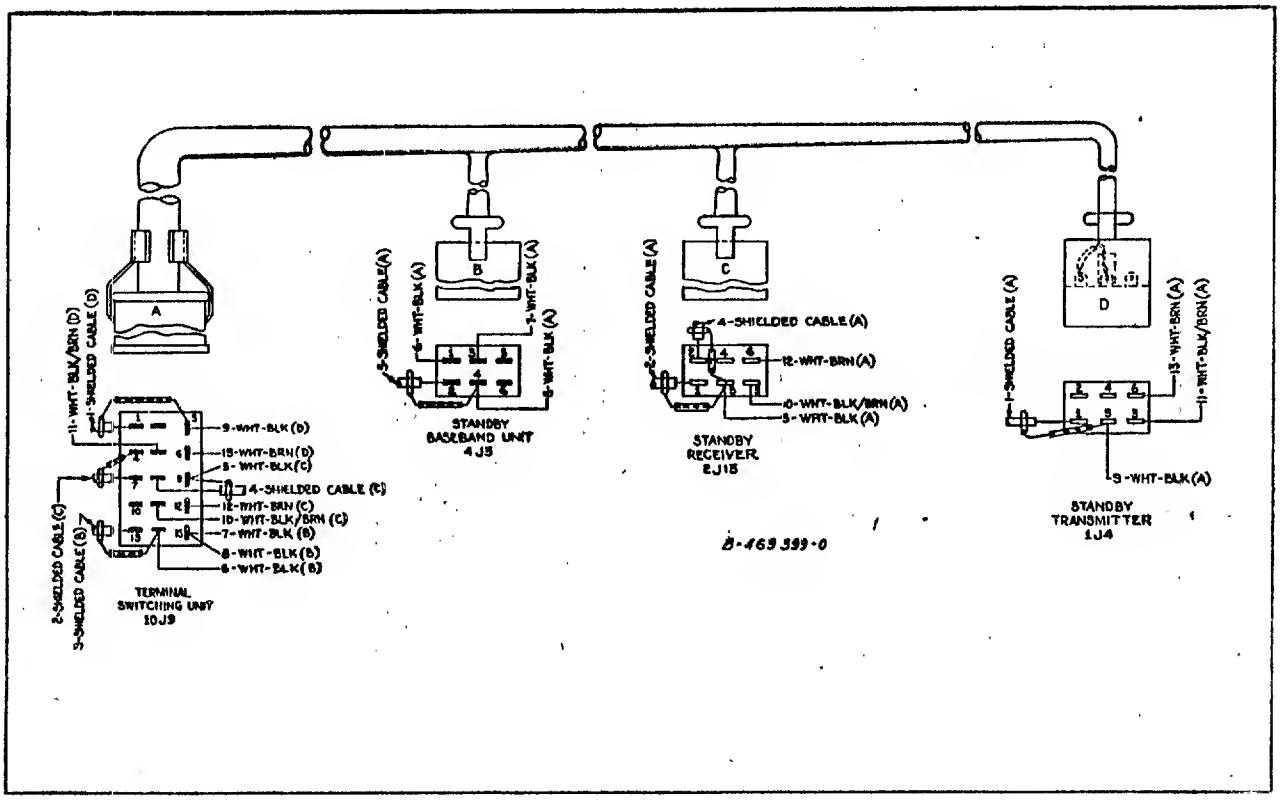


Figure 19—Terminal Standby Rack Connecting Cable Diagram, MI-31022-B, Item 4

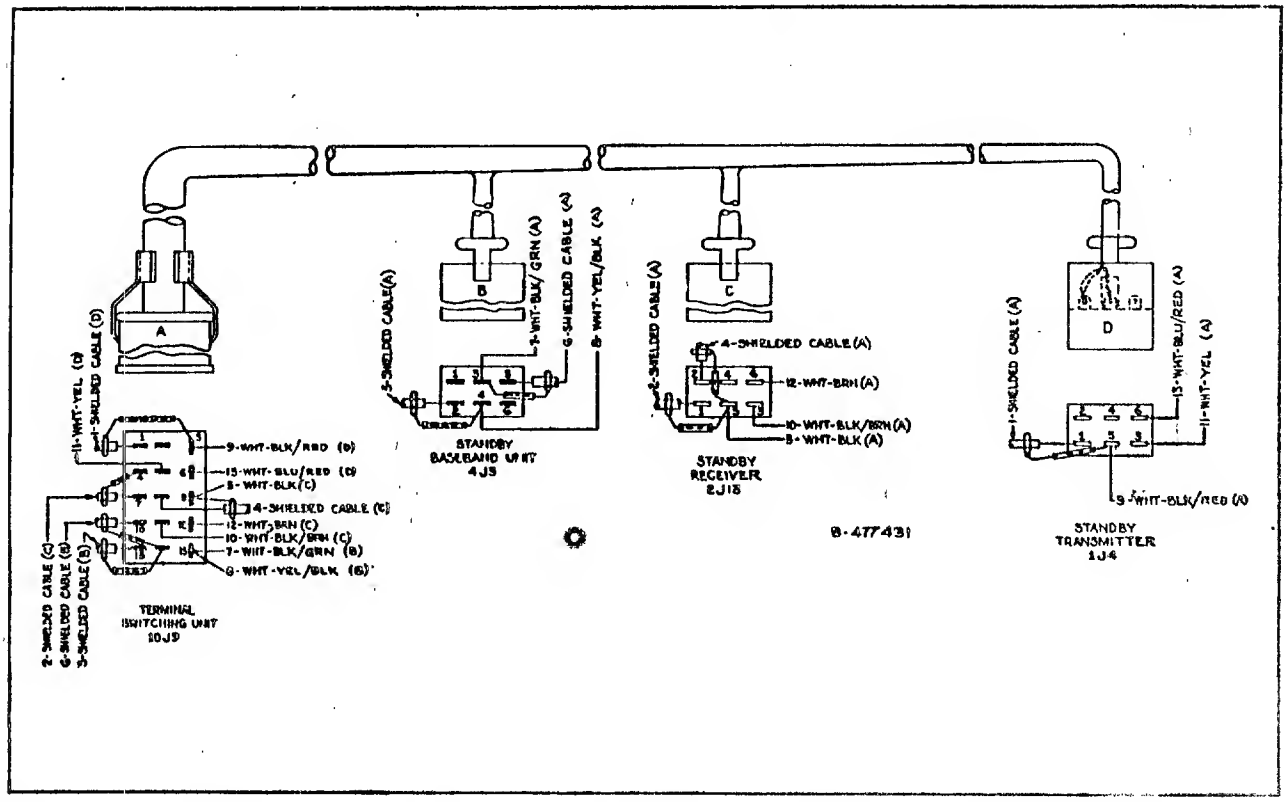


Figure 19A—Terminal Standby Rack Connecting Cable Diagram, MI-31022-C, Item 4

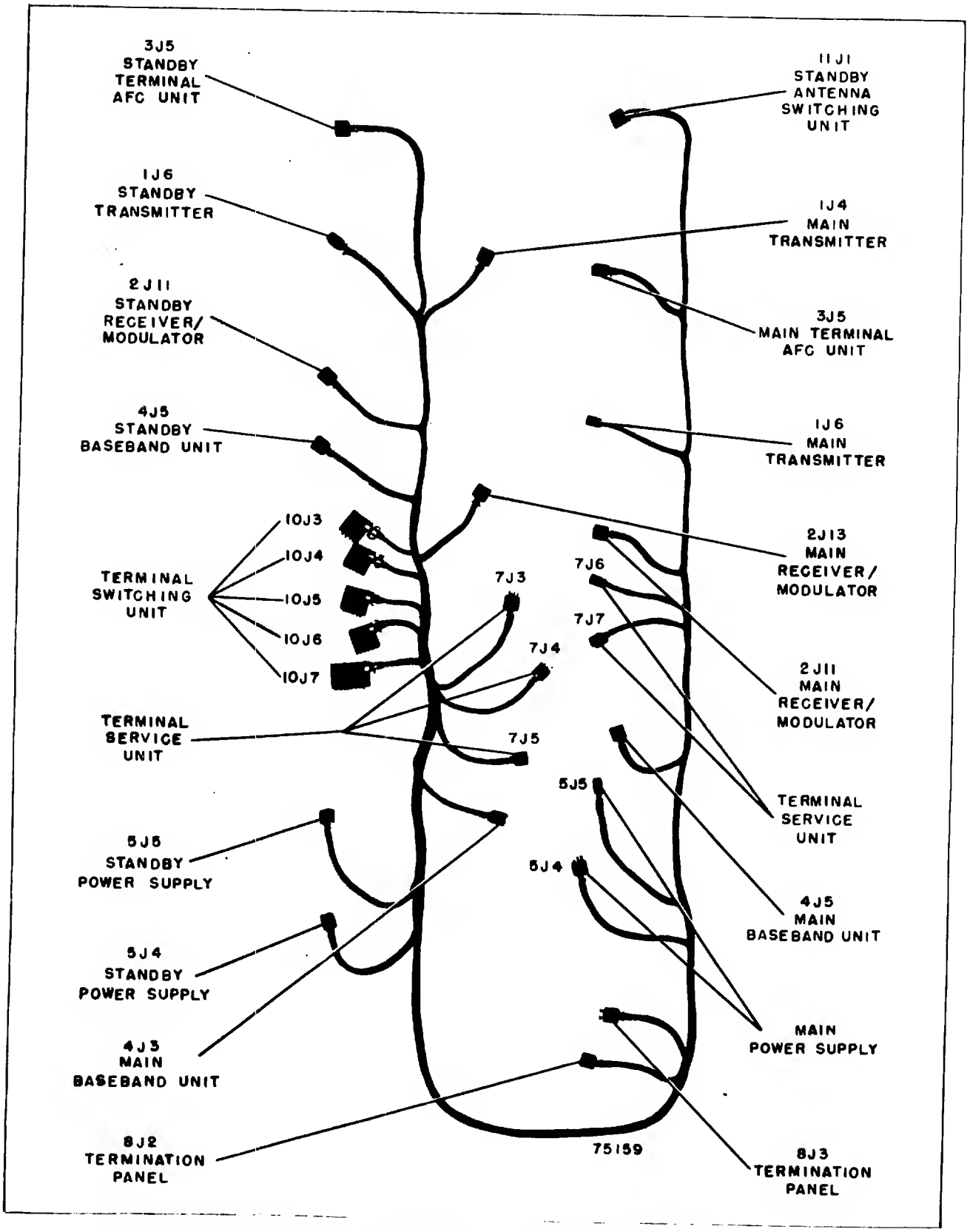


Figure 20—Terminal Standby Station Interconnecting Cable, MI-31022-B, Item 3

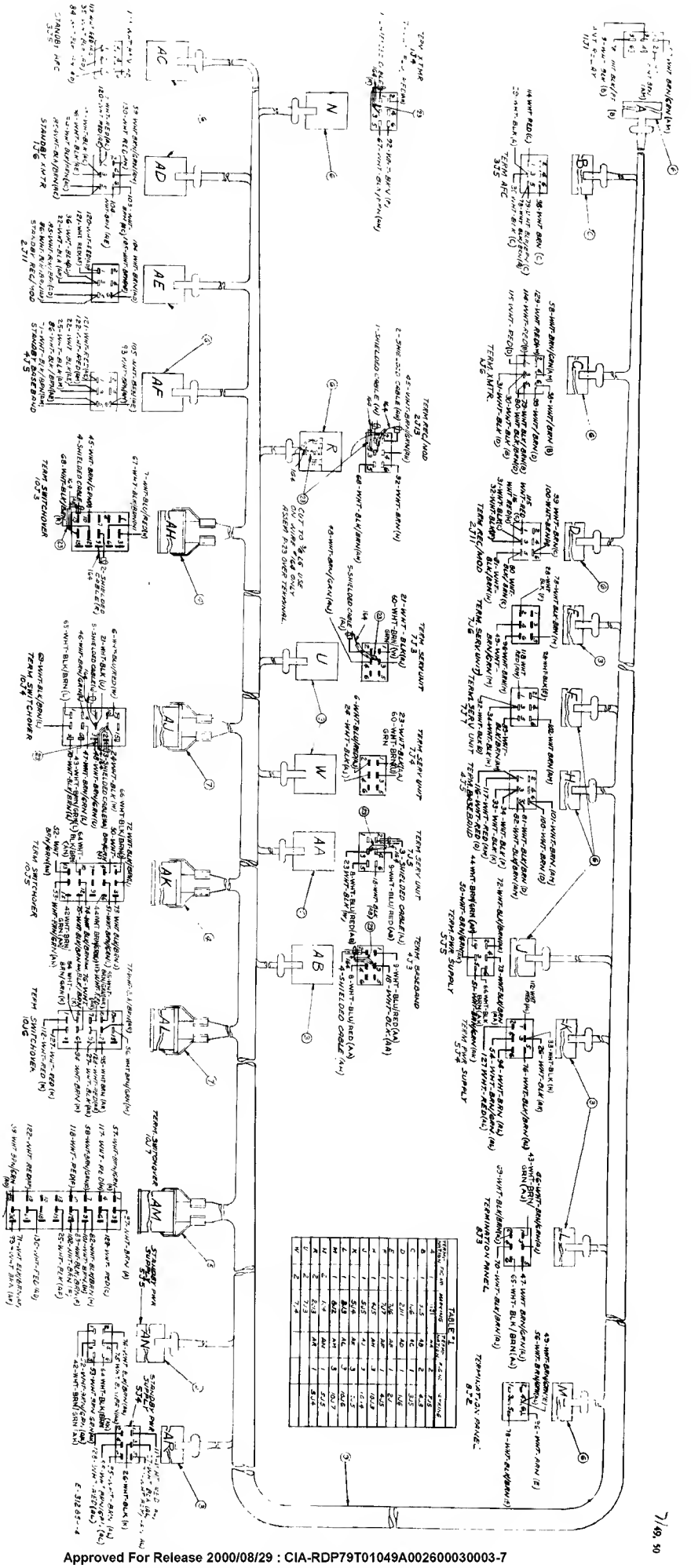


Figure 21—Terminal Standby Station Interconnecting Cable Diagram, MI-31022-B, Item 3

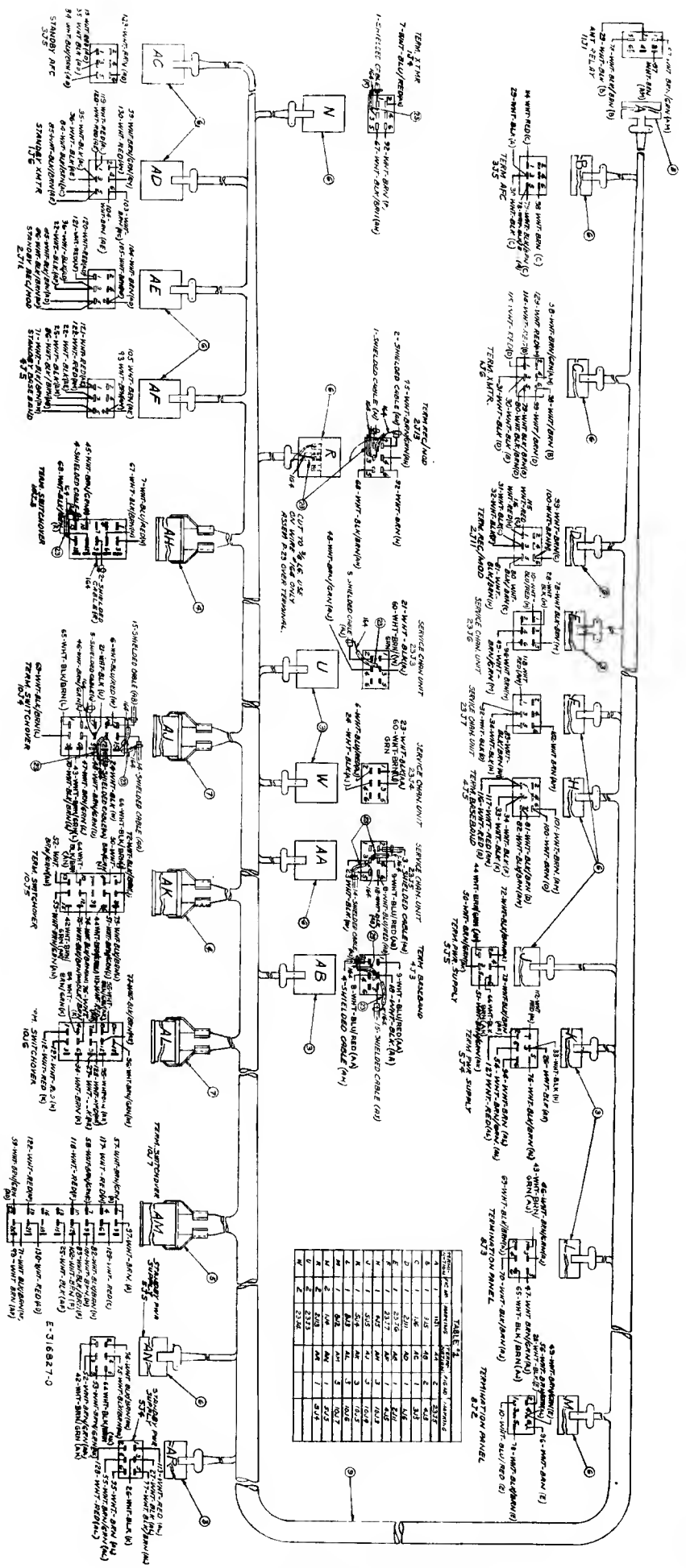
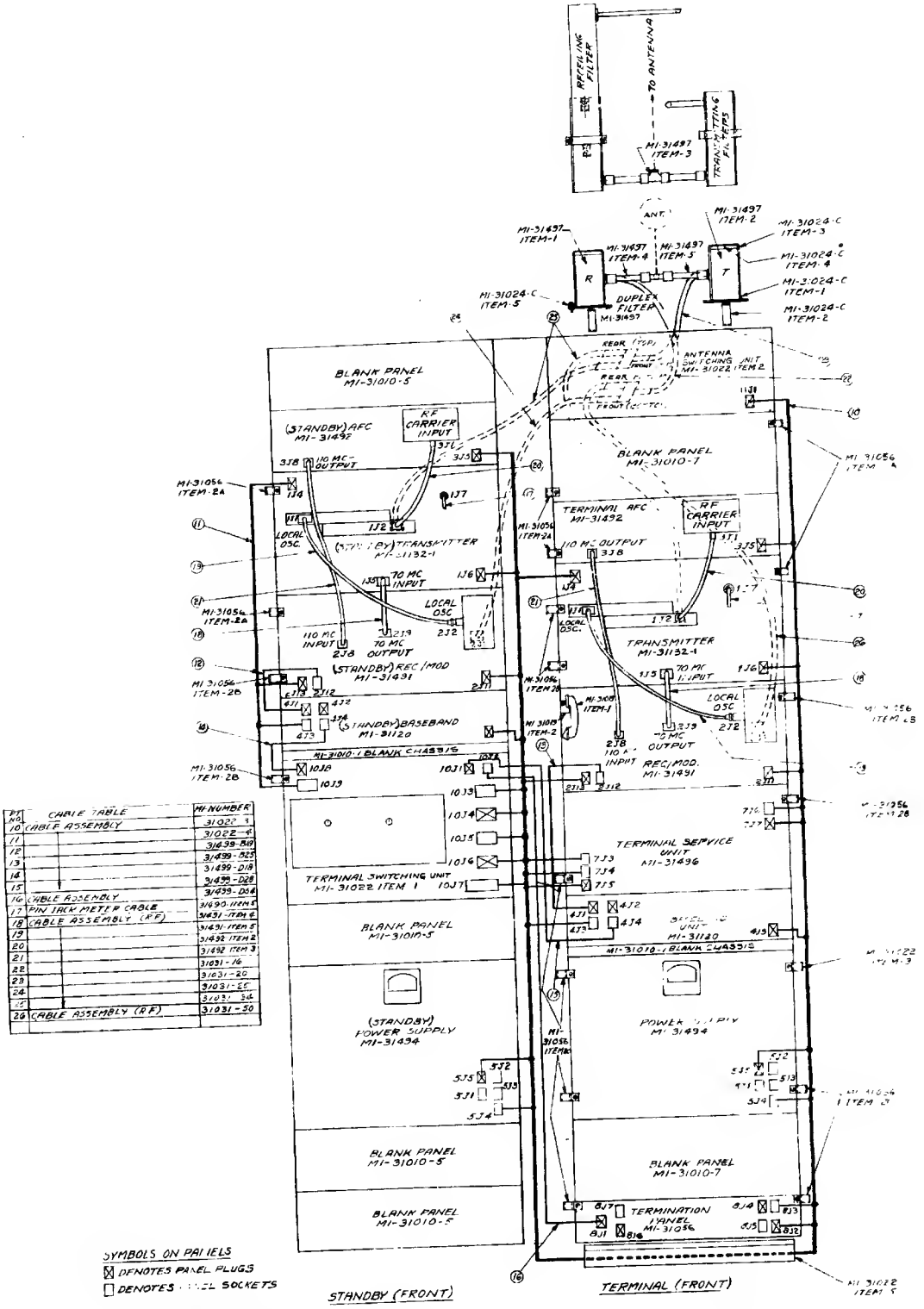


Figure 21A—Terminal Standby Station Interconnection Cable Diagram, MI-31022-C, Item 3



PT NO	CABLE TABLE	MI NUMBER
10	CABLE ASSEMBLY	31022-9
11		31022-6
12		31439-849
13		31439-925
14		31439-D18
15		31439-D28
16	CABLE ASSEMBLY	31439-D04
17	PIN JACK METER CABLE	31490 ITEM 5
18	CABLE ASSEMBLY (RF)	31431 ITEM 8
19		31431 ITEM 5
20		31492 ITEM 2
21		31492 ITEM 3
22		31031-16
23		31031-20
24		31031-EE
25		31031-34
26	CABLE ASSEMBLY (RF)	31031-50

SYMBOLS ON PANELS
⊠ DENOTES PANEL PLUGS
□ DENOTES PANEL SOCKETS

GENERAL NOTES:
SUFFIX LETTERS FOR MI'S ARE AS SHOWN ON LIST OF PARTS
NUMBERS IN BALLOONS REFER TO PT. NO. IN CABLE TABLE
FOR LIST OF PARTS SEE CI9100-503 & 504
FOR MORE DETAILS OF REPEATER STANDBY STATIONS SEE DWG 312872
FOR MORE DETAILS OF TERMINAL STANDBY STATIONS SEE DWG 630351
FOR MORE DETAILS OF NON-STANDBY STATIONS SEE DWG 312835
FOR EXAMPLES OF CABINET MOUNTING SEE DWG 312872
FOR EXAMPLES OF RACK MOUNTING SEE DWG 312872
FOR EQUIPMENT SYMBOLS SEE DWG 743640
MI COMPONENTS OF THIS EQUIPMENT ARE TO BE PREPARED FOR SHIPPING PER COMPONENT MI SHEETS

Figure 22—CW-20A (MM-20A) Terminal Standby Station—Cabling Diagram

51 52

1R14. A suggested setting for the red needle of 1M2 is 50 μa, but in individual cases, experience may show a better value.

Standby Lockout Circuit

To test and adjust the standby lockout circuit of the receiver/modulator perform the following steps:

1. Remove the rf signal from the receiver/modulator. Remove 2V1 and lockout relay 2K3.

2. Turn the "NOISE GAIN" potentiometer 2R115 fully clockwise. Note the current reading at the OPR CUR jack (the 0 to 200 μa test meter located in the transmitter may be used). The current should read between 40 and 60 μa.

3. Maintaining conditions as above, insert the lockout unit relay. "OPR CUR" should not rise more than 5μa above the value noted in (2) above.

4. Maintaining conditions as above replace 2V1. The current at the "OPR CUR" jack should read between 110 and 190 μa.

5. Vary the "NOISE GAIN" potentiometer. Starting at the fully counter-clockwise position, note the OPR CUR reading at which the lockout relay just operates. This should be no more than 25 μa above the reading of (2) above. Adjust the "NOISE GAIN" for an "OPR CUR" reading of 110 μa.

NOTE: The current at the "OPR CUR" jack is dependent on the strength of the applied rf signal. Therefore when an rf signal is applied to the receiver/modulator the "OPR CUR" may drop from the 110 μa value set above. With a very strong signal the current reading may drop to approximately the reading of (2) due to the saturation of IF stage 2V5 which limits off the noise on the signal. Thus, when adjusting the "NOISE GAIN" control for the proper current reading it is important to remove the rf signal from the receiver/modulator.

6. Check operation of the receiver/modulator relays and the lockout relay using the following table:

Condition	*B+ at 2V15-5*	*Voltage between 2J11-5 & 2J13-6*	*Voltage between 2J11-5 & 2J13-4*
With r-f signal	210 vdc	115 vac	0
No r-f signal	0	0	0
2V1 removed	0	0	115 vac

7. Restore the receiver/modulator to normal operating conditions. The standby lockout unit is now ready for operation.

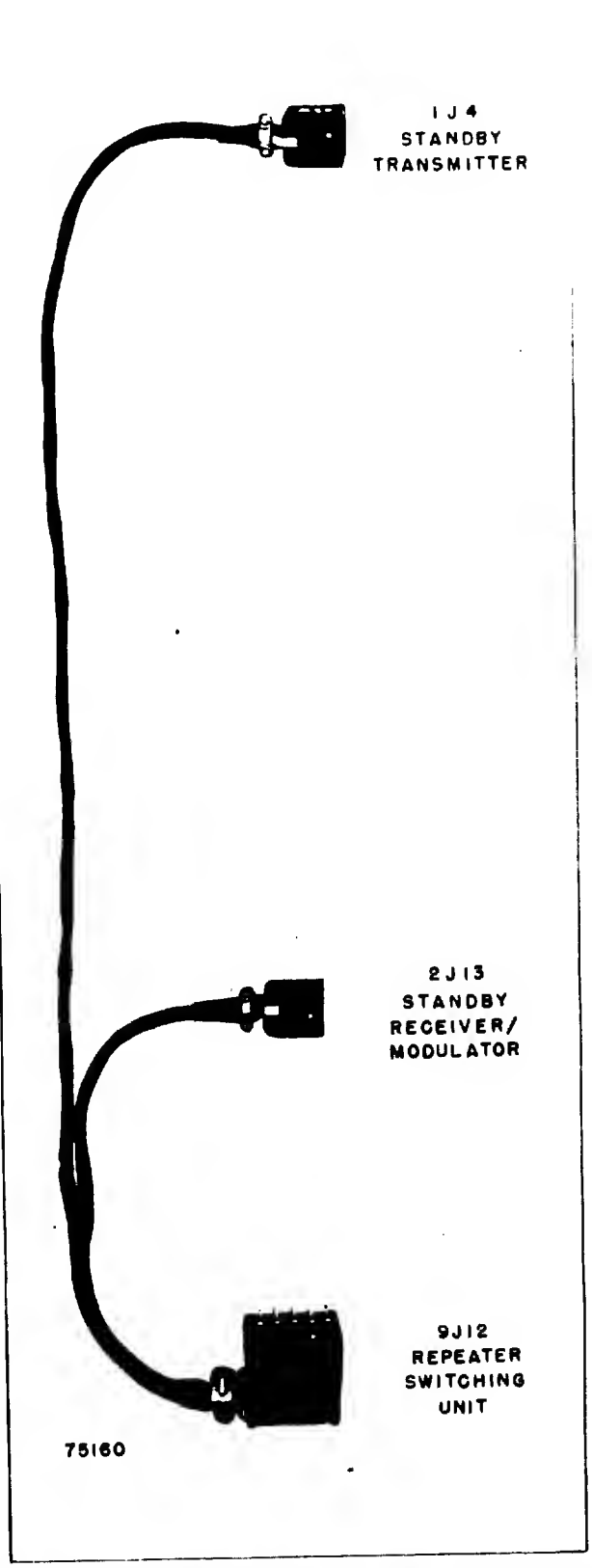


Figure 23—Repeater Standby Rack Connecting Cable, MI-31021-B, Item 3

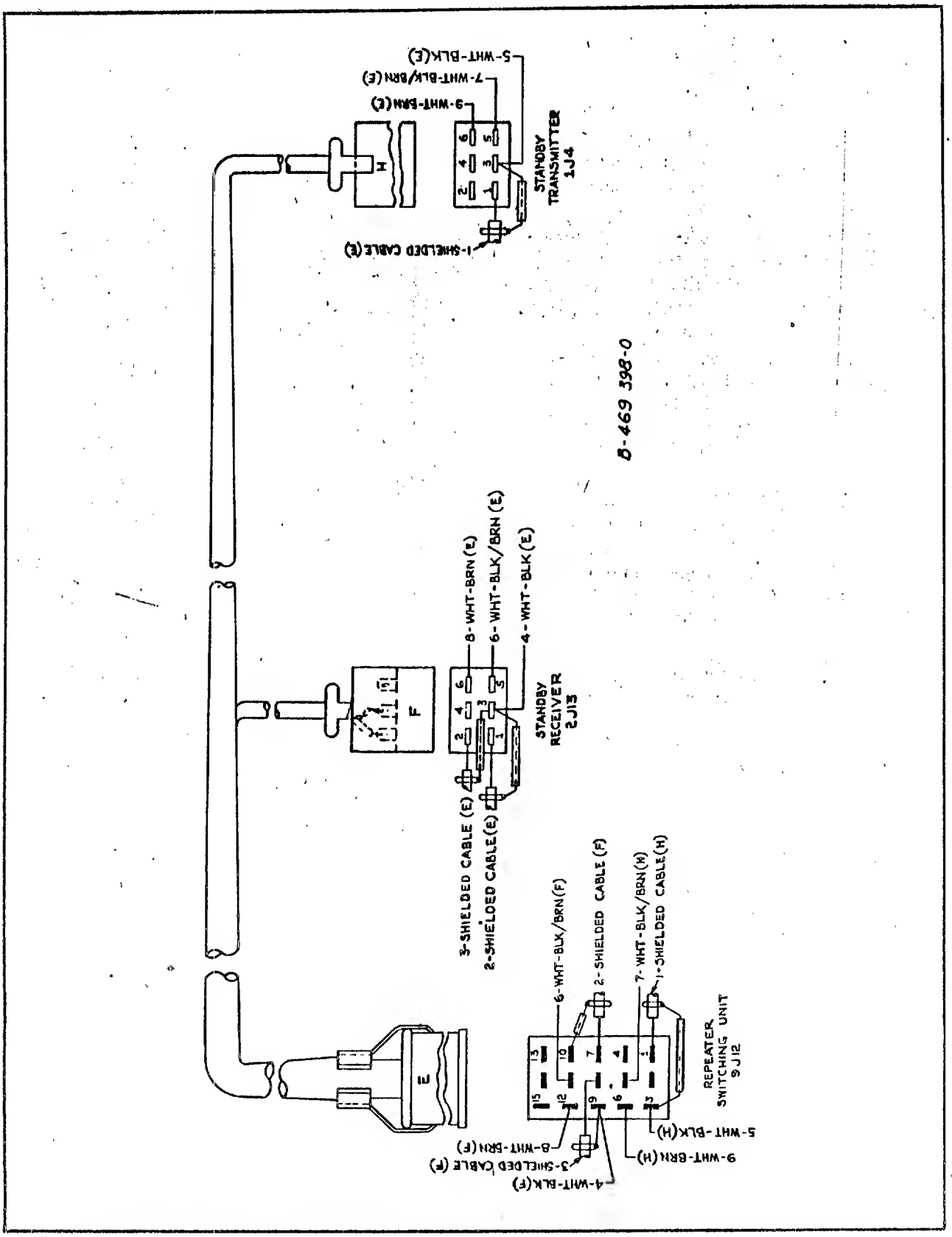


Figure 24—Repeater Standby Rack Connecting Cable Diagram, MI-31021-B, Item 3

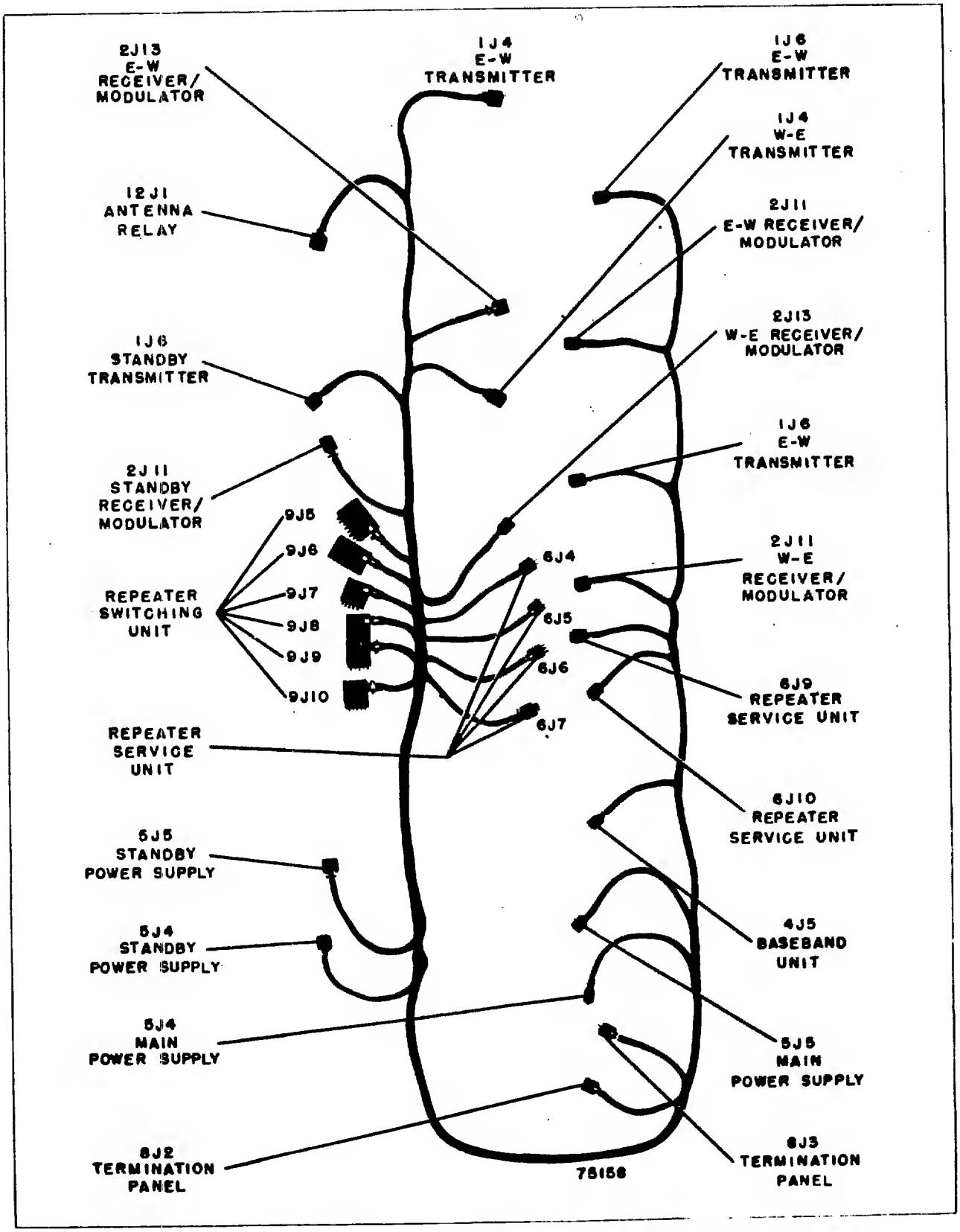


Figure 25—Repeater Standby Rack Interconnecting Cable, MI-31021-B, Item 2

OPERATION

After the Initial Adjustments have been completed, the standby station is ready for operation on a continuous 24 hour-a-day schedule. By placing the LINE switch of the switching unit on the "LINE" position, operating power is supplied to the station. The LINE lamp will be lit indicating that the station power is "ON."

The operation of the standby switching equipment, once the station is put into operation, is completely automatic. When a receiver, transmitter or power supply fault occurs the standby equipment is promptly switched into operation in place of the main equipment.

After the faulty unit or units have been repaired or replaced, the main equipment can be quickly put back into operation by pressing the RESET button on the switching unit. The standby equipment is taken out of service and all of the main equipment is restored to operation regardless of whether the standby radio equipment, the standby power supply or both have been operating.

By pressing the MAN SW TO STDBY-TERM and PWR SUP buttons at a terminal station or the MAN SWITCH TO STANDBY-E-W or W-E and PWR SUP buttons at a repeater station, the operational efficiency of the switching equipment can be quickly checked. It is also a ready means of operating the switching equipment for the purpose of wiping the relay contacts clean to prevent the accumulation of excessive corrosion. When any of the MAN SWITCH TO STANDBY-TERM, -E-W or W-E pushbuttons are pressed the switchover to standby radio equipment operation will occur immediately. Likewise immediate power supply switching will occur when the MAN SWITCH TO PWR SUP pushbutton is pressed if relay 9K1 (or 10K1) is not in its delay cycle.

When the standby radio equipment is switched into operation at a terminal station, as the result of a receiver fault or the pressing of the MAN SW-TERM button, the indications are as follows: The TERM lamp goes out, the STANDBY lamp lights on the switching unit and at the service unit, lamp "R" will light and the buzzer will sound. A transmitter fault will light the service unit "T" lamp instead of the "R" lamp and will result in the other indications above. The switchover to standby power supply at a terminal station due to either a fault or the pressing of the MAN SW-PWR SUP will be indicated by the lighting of lamp "R" and sounding of the buzzer at the service unit, and the lighting of the TEST lamp in the switching unit. Also, the main power supply pilot lamp goes out and the standby power supply lamp comes on.

When the standby radio equipment is switched into operation at a repeater station as a result of a fault or the pressing of the MAN SWITCH-E-W or W-E button, the E-W or W-E lamp will go out and the STANDBY lamp will light. When switchover to the standby power supply occurs at a repeater station, the switching unit test lamp and the standby power supply pilot lamp light, and the main power supply pilot lamp goes out.

Keep the TEST PWR switch in the OPR position during normal station operation. The TEST lamp is on when the TEST PWR switch is on the TEST position or when the standby power supply is operating. The TEST position is used only when trouble-shooting is being performed as described in the "Maintenance" section.

MAINTENANCE

Frequent maintenance checks at all stations of a CW-20A (MM-20A) Microwave Relay System are of vital importance in order to keep the equipment in perfect working order so that there will be no interruptions in the 24 hour-a-day service at any time, anywhere in the system. The standby stations of a CW-20A (MM-20A) Microwave Relay System require specific maintenance information for the standby switching equipment in addition to maintenance instructions for the standard terminal or repeater station equipment. The maintenance information for the main and standby radio and power supply equipment used at standby stations is supplied by the basic equipment instruction books.

The following standby switching equipment maintenance instructions in conjunction with the basic equipment instruction books provides complete instructions for performing routine operational checks and for trouble-shooting at CW-20A (MM-20A) microwave standby stations.

General

1. The MI-31494 power supply, because of different power requirements when used at standby stations, is fused in accordance with the following table. This table applies to the main and standby power supplies, at all terminal standby and repeater standby stations.

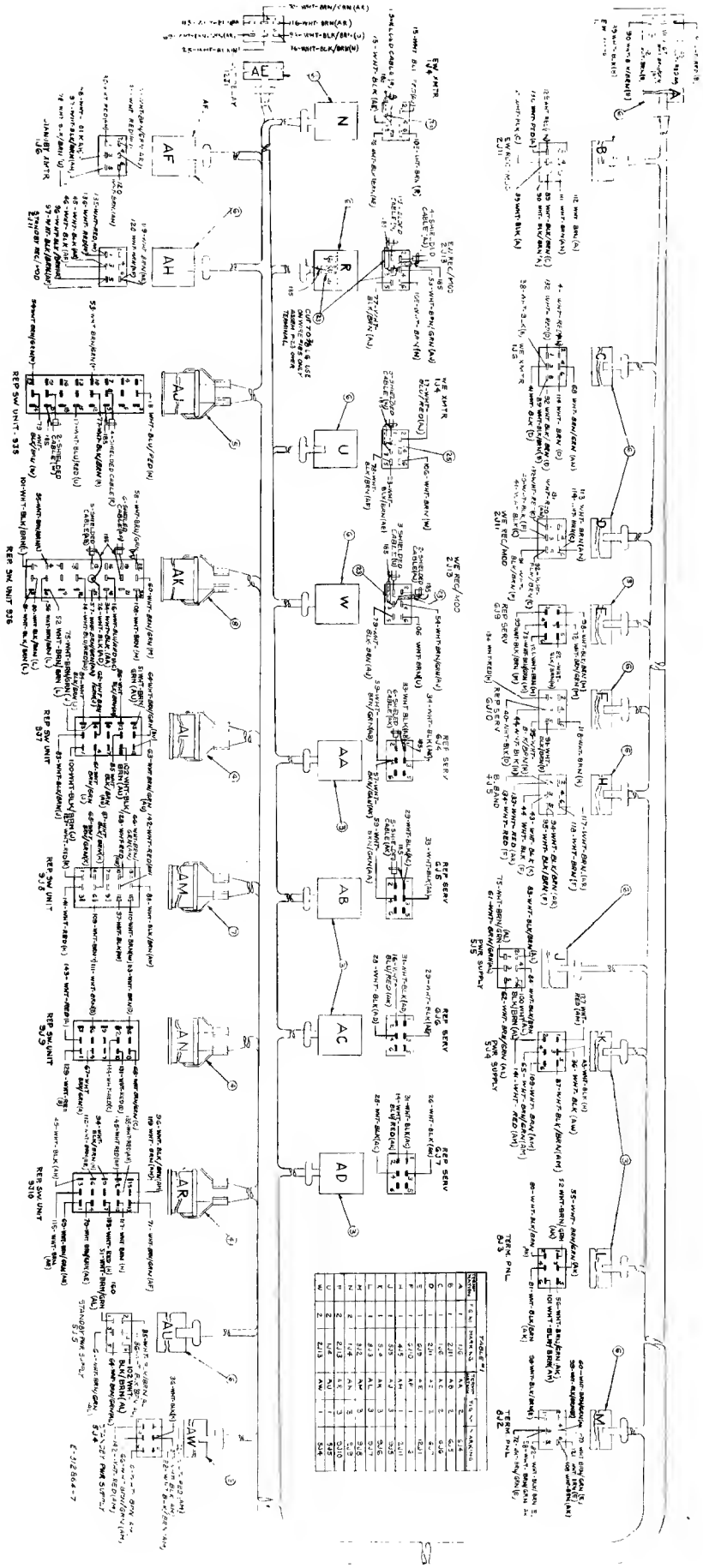


Figure 26—Repeater Standby Rack Interconnecting Cable Diagram, MI-31021-B, Item 2

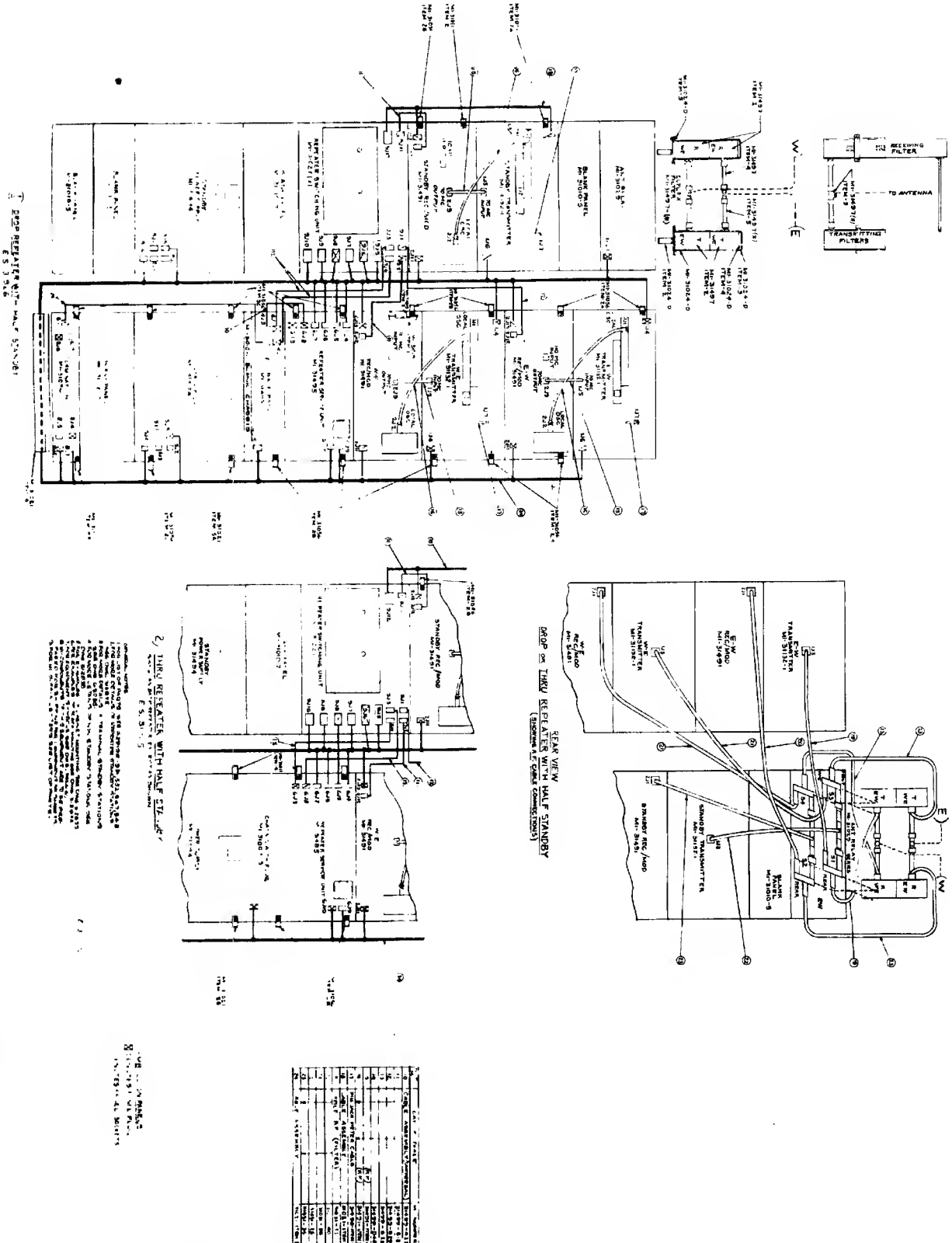


Figure 27—CW-20A MM-20A Repeater Standby Station—Cabling Diagram

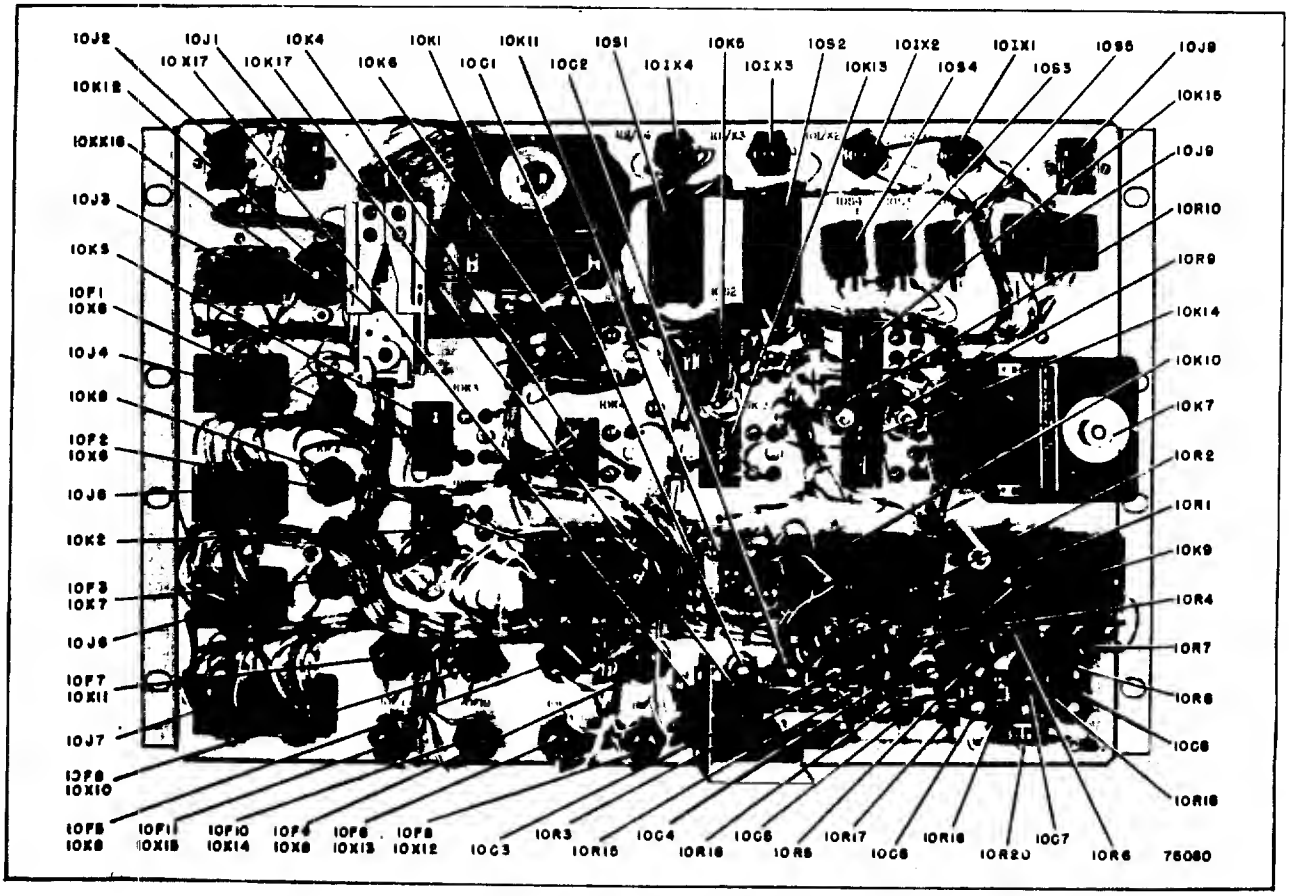


Figure 28—Terminal Switching Unit, MI-31022-B, Item 1 (rear view)

Symbol	*Panel Marking*		*Rating*
5F6	LINE	Primary	10A 250 V*
5F7	250 VOLT SUPPLY	Primary	2.5A 250 V*
5F8	500 VOLT SUPPLY	Primary	5A 250 V*
5F9	250 DC REG	Common	Not Fused
5F10		Common	" "
5F11	250 DC	W-E	" "
5F12	500 DC	W-E	" "
5F13	REG.	W-E	" "
5F14	UNREG.	W-E	" "
5F15	250 DC	E-W	0.8A 250 V
5F16	500 DC	E-W	0.8A 250V
5F17	REG.	E-W	2.5A 32 V
5F18	UNREG.	E-W	2A 32 V

All fuses are Bussman type MDM Fusetrons or equivalent, except those marked *, which are Bussmann type FNM Fusetrons or equivalent.

2. All relays should be operated at least once a month, and more often if possible. This can be done at a time when system traffic is light and short interruptions in service (during switchover and reset) can be tolerated. This will enable the relay contacts to wipe themselves clean before excessive film or corrosion can be accumulated. Operation of the relays gives a good check on switching unit operation.

3. Replace the electrolytic capacitor 10C9 once a year.

Terminal Standby Station

Check the relay operation of the terminal switching unit by performing the following:

1. Simulate a transmitter fault by advancing the red needle of main transmitter monitor 1M2 until it contacts the black needle. Immediate switchover of radio equipment should take place. Restore the red needle to its original setting. Allow the standby equipment to come into full operation and make routine maintenance checks on it, as described in the basic equipment instruction books. Press RESET button 10S5 to transfer back to operation of main equipment.

2. After the main equipment is again operating normally, simulate a receiver/modulator fault by pulling out 2V1, the first IF tube, of the main receiver/modulator. Switchover should take place in approximately six seconds. If it fails to do so, check the adjustment of REL. OSC CONTROL 2R46 in the receiver/modulator, and of NOISE

GAIN control 16R4 in the standby lockout unit (or 2R115, if the receiver/modulator is MI-31491-B)

3. Turn off TRANS. TUNE switch 5S2 in the main power supply. Switchover to operation of standby power supply should occur at once. Permit the standby power supply to come into full operation. Check its output voltages and see that all standby equipment is operating properly. Replace 2V1 in the main receiver/modulator, turn on TRANS. TUNE switch 5S2 in the main power supply, and press RESET button 10S5 to restore operation of all main equipment.

4. Repeat the switchovers of steps 1, 2 and 3 several times if possible, in order to give the relay contacts additional cleaning.

Repeater Standby Station

Check the relay operation of the repeater switching units by performing the following:

1. Simulate an E-W transmitter fault by advancing the red needle of E-W transmitter monitor 1M2 until it contacts the black needle. Immediate E-W switchover should take place. Restore the red needle to its original setting. Allow the standby equipment to come into full operation.

2. Make routine checks on the standby radio equipment as described in the basic equipment instruction books.

3. Press RESET button. After all main equipment is again operating normally, repeat step 1, using the W-E transmitter monitor After the standby equipment comes into full operation, press RESET button 9S6.

4. When all main equipment is again operating normally, simulate an E-W receiver/modulator fault by pulling out 2V1, the first IF tube, of the E-W receiver/modulator. E-W switchover should occur in approximately five seconds. If it fails to do so, check the adjustment of REL. OSC. CONTROL 2R46 in the E-W receiver/modulator, and of NOISE GAIN control 16R4 in the E-W standby lockout unit (or 2R115, if the receiver/modulator is MI-31491-B).

5. Turn off TRANS TUNE switch 5S2 in the main power supply. Switchover to operation of standby power supply should occur at once. Per-

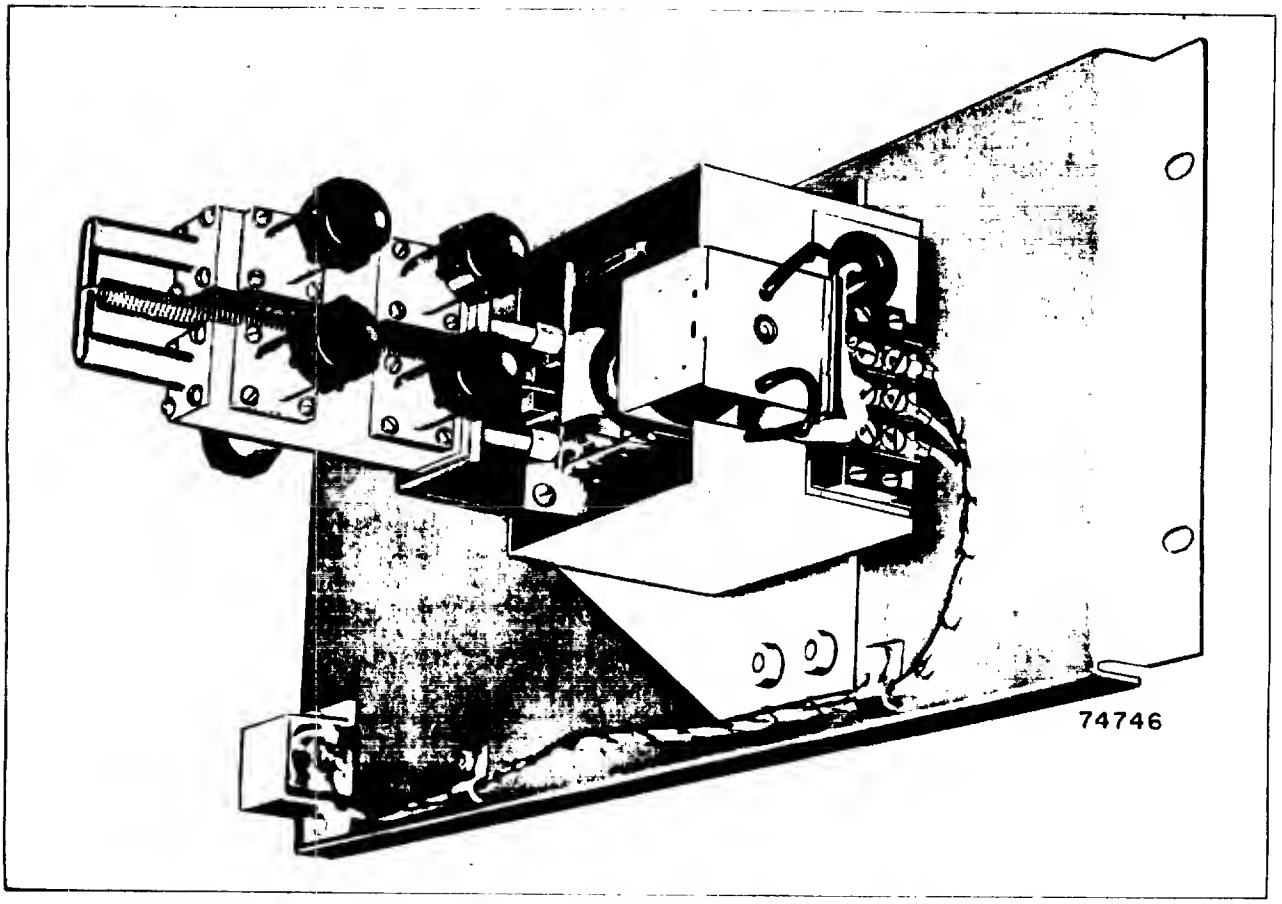


Figure 29—Terminal Antenna Switching Unit, MI-31022-B, Item 2 (rear view)

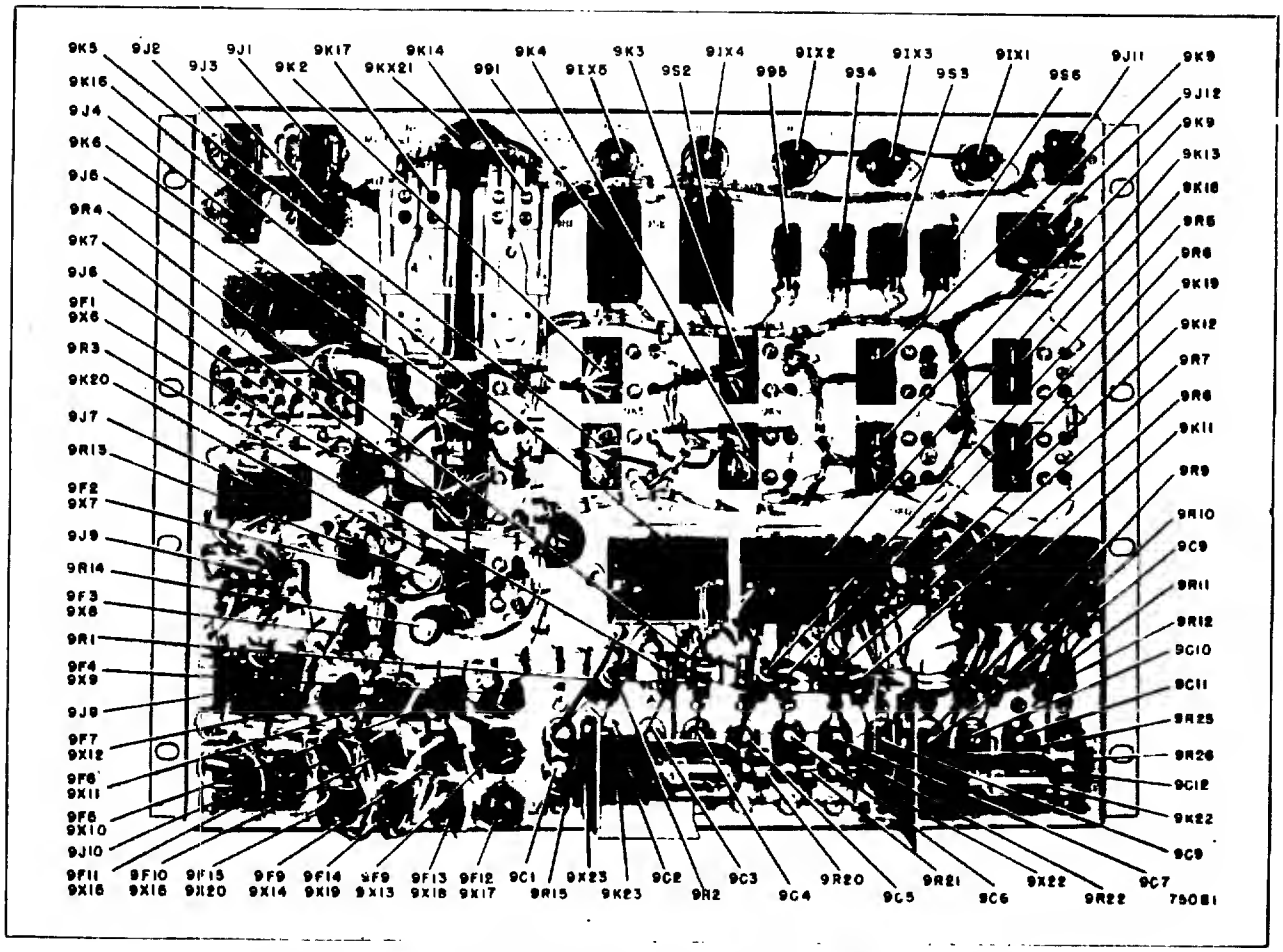


Figure 30—Repeater Switching Unit, MI-31021-B (rear view)

mit the standby power supply to come into full operation. Check its output voltages and see that all standby equipment is operating properly. Replace 2V1 in the E-W receiver/modulator, turn on TRANS TUNE switch 5S2 in the main power supply, and press RESET button 9S6 to restore operation of all main equipment.

6. Repeat step 4, using the W-E receiver/modulator. When standby equipment comes into full operation, press RESET button 9S6.

7. Repeat the switchovers of steps 1, 3, 4, 5 and 6 several times if possible, in order to give the relay contacts additional cleaning.

TROUBLE SHOOTING

General

NOTE: The following trouble-shooting instructions apply to both the terminal and repeater standby stations. These instructions are described in terms of the terminal station but they will apply as well to the repeater station by substituting the items enclosed in parentheses for the equivalent terminal station items.

1. If in the preceding relay operation check any difficulty is encountered, such as failure to switchover, LINE switch 10S1 (9S1) should be turned off and the dust covers of the switching unit removed.

The following caution note applies to IB-33021-B and IB-33022-B only.

CAUTION: THE FRONT DUST COVER OF THE SWITCHING UNIT SHOULD NEVER BE REMOVED OR REPLACED WHILE LINE SWITCH 10S1 (9S1) IS CLOSED. In coming off and going on this cover comes very close to relay contacts which carry dangerous voltages when the power is on. Serious injury to personnel and short circuit equipment damage are likely if this precaution is not strictly observed.

With power off, the cover should be removed and replaced carefully, to avoid mechanical damage to relay springs.

2. With the dust cover off turn on 10S1 (9S1) and proceed to the point where the trouble was observed. By the use of the block diagrams of figures 4, 5, 6 (figures 9, 10, 11) schematic diagram of figure 7 (figure 12) connection diagram of figure 32

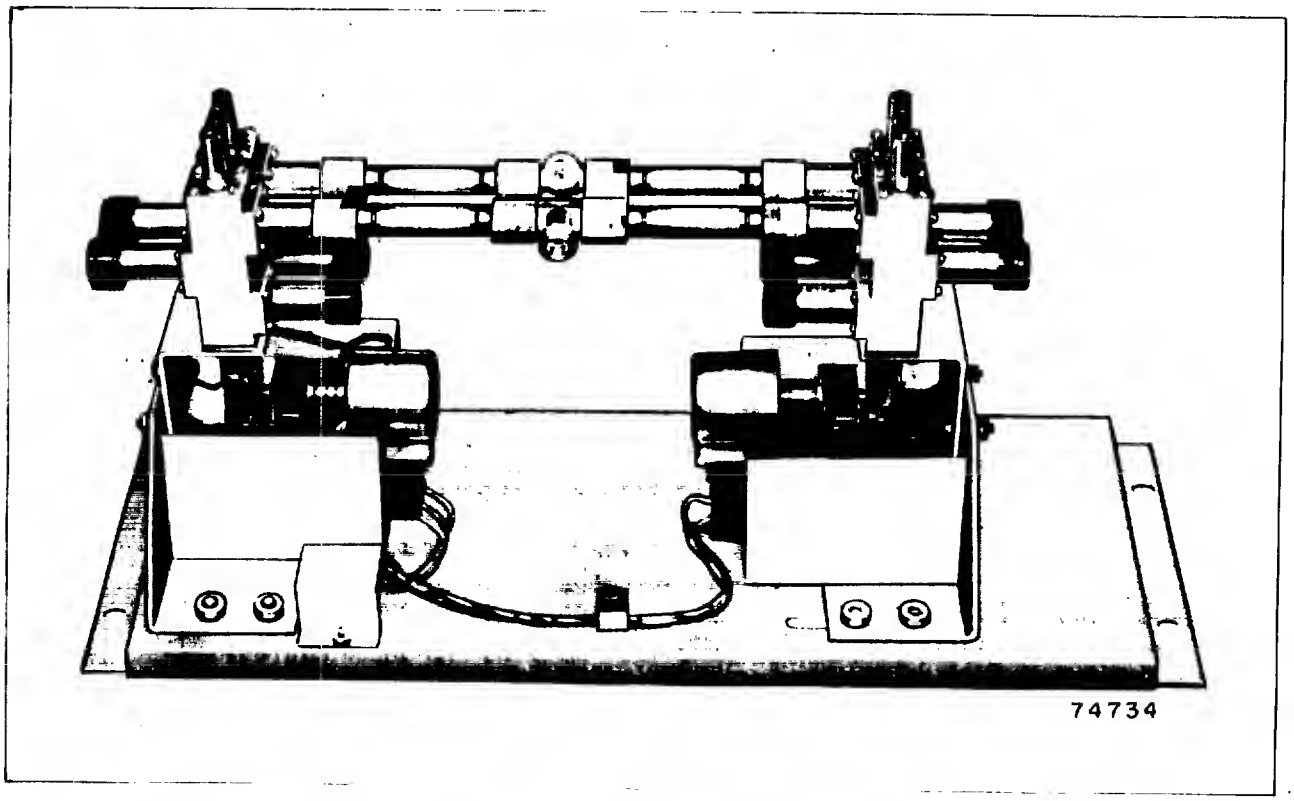


Figure 31—Repeater Antenna Switching Unit, MI-31029-B (rear view)

(figure 32A for MI-31022-C) (figure 33), cable connection diagram of figure 22 (figure 27), visual observation of relay action, voltage measurement with the power on and continuity measurements with the power off, the trouble can be diagnosed.

3. If the trouble is corroded contacts, attempt to clear it by repeated operation of the relay, either electrically or manually. This trouble should be watched for particularly in the contacts of 10K12 (9K14 and 9K17), and in contacts 9-10, 11-12, and 13-14-15 of 10K6 (13-14-15 or 9K6 and 9K7). The low voltages present at these contacts will not aid in breaking down film, so it must be done by contact wiping action alone. The trouble is minimized, however, by the use of bifurcated-spring twin contact relays for all but the power-type relays. If contact film and corrosion should cause trouble, which repeated operation of the relay fails to clear, the contacts should be very carefully burnished with a standard relay contact burnishing tool.

4. If the trouble is due to contacts being out of adjustment, they should be carefully adjusted with a standard relay spring-bender. This should be done only when trouble occurs or appears imminent. The initial factory adjustment of relay springs is superior to field adjustment, and should not be disturbed except when necessary.

NOTE: Make all relay adjustments with power off.

Switching Unit Disabling

1. When it is necessary to do work on the main (E-W or W-E) equipment which might result in an undesired switchover to standby operation, the switching unit can be disabled by removing SW PANEL AC fuse 10F1 (9F1). Be sure to replace the fuse when the work is finished. At terminal stations only, protection from switchover due to transmitter faults only can be obtained by turning off TERMINAL FAULTS switch 7S5 in the terminal service unit. This switch should be closed again when the work is finished.

2. If the standby power supply is in operation when 10F1 (9F1) is removed, the equipment will reset to operation of the main power supply, and will remain in this condition even if the main power supply has failed.

3. At a terminal station, if 10F1 is removed while the standby radio equipment is in operation, the equipment will reset to operation of the main radio equipment. However, the antenna relay will not reset, since in order to do so it requires ac power on its "normal coil," and the removal of 10F1 removes that power. This will put the station off the air until the fuse is replaced or the antenna relay is reset manually.

4. At a repeater station, if 9F1 is removed while the standby radio equipment is in operation, the equipment will reset to operation of E-W and W-E radio equipment. However, the antenna relay which was in standby condition before the fuse was removed will remain in standby condition, since with the fuse removed there is no power to operate it back to its "normal" condition. In this case, one direction of the repeater station will be off the air until the fuse is replaced or the antenna relay is reset manually.

Servicing Non-Operating Units with Power On

It is sometimes desirable to trouble-shoot with power on in units that have failed. In this section, such a unit will be called "non-operating," since if it is a part of the main equipment, the standby equipment will be in operation in the system, and vice-versa. To connect this faulty equipment to the operating power supply might overload the supply and interfere with operation of the system. To avoid this, the large standby cable is disconnected from E-W plug 5J4 of the non-operating power supply and from the power plug of the faulty unit, and a suitable patch cord is connected from 5J4 to the power plug of the faulty unit. Then 10S2 (9S2), TEST POWER switch, in the switching unit is thrown to TEST. This connects the two power supply inputs in parallel, so that the non-operating supply is energized, no matter which it is, main or standby It is now possible to shoot trouble with the power on. Care should be taken, however, since with a less-than-normal load on the non-operating power supply, its dc output voltages will be higher than normal. When the work is finished, 10S2 (9S2) TEST POWER switch should be returned to OPR and the standby cable reconnected.

If the equipment operates from a line regulator, TEST POWER switch 10S2 (9S2) should not be used unless it is assured that parallel operation of two power supply inputs will not overload the regulator and interfere with the operation of the system. If such operation would overload the regulator, the large standby cable should be disconnected from power plug 5J5 in the non-operating power supply and a patch cord connected from 5J5 to an unregulated service outlet.

LIST OF PARTS

Symbol No.	*Description*	*Drawing No.*	*Stock No.*
	TERMINAL SWITCHING UNIT MI-31022-A, -B, -C, ITEM 1		
10C1 to 10C8 Incl.	Capacitor, fixed, paper oil impregnated 0.5 mf ±10% 1000 vdc	984681-14	56914
10C9	Capacitor, dry electrolytic, 10/10/10 mf, 450 v., plug-in type	449618-1	56304
10F1	Fuse, cartridge, glass body, non-renewable, 1 amps., 32 v. 1¼" lg. x 13/32" dia.	8835338-9	94877
10F2	Fuse, cartridge, glass body, non-renewable, 15/100 amp., 250 v. 1¼" lg. x 13/32" dia.	8835338-10	95578
10F3	Fuse, cartridge, glass body, non-renewable, 8/10 amp., 250 v. 1¼" lg. x 13/32" dia.	8835338-4	95111
10F4	Fuse, cartridge, glass body, non-renewable, 4/10 amp. ,250 v. 1¼" lg. x 13/32" dia.	8835338-7	95558
10F5	Fuse, cartridge, glass body, non-renewable, 3/10 amp., 250 v. 1¼" lg. x 13/32" dia.	8835338-3	95110
10F6	Fuse, cartridge, glass body, non-renewable, 8/10 amp., 250 v. 1¼" lg. x 13/32" dia. (same as 10F3)	8835338-4	95111
10F7	Fuse, cartridge, glass body, non-renewable, 1 amp., 32 v. 1¼" lg. x 13/32" dia.	8835338-9	94877
10F8, 10F9	Fuse, cartridge, glass body, non-renewable, 3/10 amp., 250 v. 1¼" lg. x 13/32" dia. (same as 10F5)	8835338-3	95110
10F10	Fuse, cartridge, glass body, non-renewable, 8/10 amp., 250 v. 1¼" lg. x 13/32" dia. (same as 10F3)	8835338-4	95111
10F11	Fuse, cartridge, glass body, non-renewable, 1 amp., 32 v. 1¼" lg. x 13/32" dia.	8835338-9	94877
10I1 to 10I4	Lamp, neon, min. bayonet base, starting volts 65 vac, 90 vdc	872291-9	91749
10J1	Connector, male, 6 contact, chassis mtg. type	181494-3	28507
10J2	Connector, female, 6 contact, chassis mtg. type	181494-4	18534
10J3	Connector, female, 15 contact, chassis mtg. type	449613-4	95561
10J4	Connector, male, 15 contacts, chassis mtg. type	449613-6	95562
10J5	Connector, female, 15 contact, chassis mtg. type (same as 10J3)	449613-4	95561
10J6	Connector, male, 15 contacts, chassis mtg. type (same as 10J4)	449613-6	95562
10J7	Connector, female, 24 contacts, chassis mtg. type	458516-1	95559
10J8	Connector, male, 6 contact, chassis mtg. type (same as 10J1)	181494-3	28507

Symbol No.	Description	Drawing No.	Stock No.
10J9	Connector, female, 15 contact, chassis mtg. type (same as 10J3)	449613-4	95561
10K1	Relay, fault lockout, time range 0–57 sec., 115 v. ac. 60 cy. 2⅛" 2 hole mtg., 2⅛" centers	8835342-1	95563
10K2	Relay, ac. coil 115 v. 60 cy. contacts 3 form "A" make, 1 form "B" break, 1 form "C" break-make	737869-1	95564
10K3	Relay, ac. coil, 115 v., 60 cy. contacts, 2 form "C" break-make	737869-2	95565
10K4, 10K5	Relay, ac. coil 115 v. 60 cy. contacts, 3 form "A" make, 1 form "B" break, 1 form "C" break-make (same as 10K2)	737869-1	95564
10K6	Relay, ac., coil 115 v., 60 cy. contacts, 3 form "A" make, 1 form "B" break, 3 form "C" break-make	737869-4	95567
10K7	Relay, fault lockout, time range 0–57 sec., 115 v. ac. 60 cy. 2⅛" 2 hole mtg., 2⅛" centers	8835342-1	95563
10K8	Relay, ac. coil 115 v., 0.1 amps., 60 cy. 145 ohms dc. res. 4 pole double throw contacts	458524-1	95568
10K9, 10K10	Relay, ac. coil 115 v., 0.1 amps., 60 cy. s.p.d.t. double break contacts 15 amps. 24 vdc or 110 vac, non-inductive	458524-2	95569
10K11	Relay, ac. coil 115 v., .043 amps., 60 cy. dc. res. 445 ohms d.p.d.t. contacts 15 amps 24 vdc or 110 vac, non-inductive	458523-1	95570
10K12	Relay, ac. coil, 115 v., 60 cy. contacts, 4 form "C" break-make	737869-3	95566
10K13, 10K14	Relay, ac. coil 115 v. 60 cy. contacts, 2 form "C" break-make (same as 10K3)	737869-2	95565
10K15	Relay dc. dual wound coil, 500/250 vdc contacts, 1 form "A" make	737886-1	95571
10K16	Relay, ac. or dc., 30 sec. time delay 115 v. heater voltage, s.p.s.t. normally open contacts, 8 pin plug-in type, hermetically sealed	458514-61	96729
10K17	Relay, ac. or dc., 5 sec. time delay, 115 v heater voltage, s.p.s.t. normally open contacts, 8 pin plug-in type hermetically sealed	458514-57	97474
10R1 to 10R8	Resistor, fixed, composition, 390 ohms ±10% 2 watt	99126-57	523139
10R9	Resistor, fixed, wire wound, 250,000 ohms ±5% 25 watt	427491-40	96264
10R10	Resistor, adjustable, wire wound, 10,000 ohms ±10% 25 watt	449695-2	97509
10R11 to 10R20 Incl.	Resistor, fixed composition, 470,000 ohms ±10%, 2 watt	99126-94	522447
10S1, 10S2	Switch, toggle, d.p.s.t., 10 amps. 250 v. 15 amps. 125 v. ball type handle	889698-1	92998
10S3, 10S4, 10S5	Switch, push type, s.p.d.t., 1 amp. 250 v. 3 amps. 125 v. with black bakelite snap on button	8835332-2	95572
Pt. of 10X1, Pt. of 10X2, Pt. of 10X3, Pt. of 10X4	Socket, pilot light, socket only less jewel and lamp	Pt. of 8856279-28	56610
Pt. of 10X1, Pt. of 10X3	Jewel, pilot lamp. red jewel only, less socket and lamp	Pt. of 8856279-28	56612
Pt. of 10X2, Pt. of 10X4	Jewel, pilot light, opal jewel only less socket and lamp	Pt. of 8856279-22	56611
10X5 to 10X15	Holder, fuse, through panel mtg. with twist lock cap	99088-1	58933
10X16, 10X17 10X18	Socket, tube, octal, black phenolic, with metal mtg. plate, For 10K16, 10K17 Relay and Capacitor 10C9	746008-43	50367
	Connector, male, 6 contact, cable mtg. type	181494-2	28454
	Connector, male, 15 contact, cable mtg.	449620-1	95574
	Connector, male, 24 contact, cable mtg. type	449620-2	95576
	Connector, female, 6 contact, cable mtg. type	449614-7	95555
	Connector, female, 15 contact, cable mtg. type	427038-7	58341
	Knob, thumb, brass, knurled hd. screw driver slotted, front cover holding	8836043-1	95573
	Relay, plug-in type, coil 8000 ohms, energize max. 1.6 ma. de-energize min. 0.75 ma., contacts s.p.d.t. 150 w. at 115 vdc (MI-31022-B only)	8888583-1	56316
	Screw, thumb, brass, knurled hd. rear cover holding	8886111-2	94391

TERMINAL ANTENNA SWITCHING UNIT MI-31022-A, -B, -C, ITEM 2

	Connector, male, 6 contact, chassis mtg. type	181494-3	28507
	Connector, female, coaxial type "N" less square mtg. flange and "U" shaped beryllium copper contact on other end	Pt. of 744073-1& 2	96934
	Contact, movable, contact rod assembly, polystyrene rod assembly, polystyrene rod with silver plated contact sleeve, anchor stud and sq. flange on rear (MI-31022-A later production only)	Pt. of 744073-1	97041

Symbol No.	Description	Drawing No.	Stock No.
	Contact, movable contact rod assembly bakelite rod, with silver plated contact sleeve, anchor stud and sq. flange on rear (MI-31022-A early production only)	Pt. of 744073-1	97453
	Contact, movable contact rod assy. bakelite rod with silver plated contact sleeve, anchor stud and sq. flange on rear (MI-31022-B only)	Pt. of 744073-2	96936
	Contact, stationary center conductor connector "U" shaped beryllium copper, silver plated, complete with # 2-56 x ¼" lg. screw & # 2 lockwasher	Pt. of 744073-1	96933
	Solenoid, coaxial switch actuating 117 vac 60 cy. intermittent duty	Pt. of 744073-1	96931
	Solenoid, coaxial switch release 117 vac 60 cy. intermittent duty	Pt. of 744073-1	96932
	Spring, coil 0.325" od. x 2⅜" lg. actuating coil release	Pt. of 744073-2	96935
	Switch, micro s.p.d.t. normally open or normally closed, 110 v. ac screw type terminals	Pt. of 744073-2	96937
	REPEATER SWITCHOVER EQUIPMENT MI-31021, -B, -C		
9C1 to 9C12 Incl.	Capacitor, fixed, paper, 0.5 mf ±10% 1000 vdc non-magnetic case, char. "A"	984681-14	56914
9C13, 9C14	Capacitor, fixed, paper, tubular molded, 0.01 mfd, ±10%, 400 vdc	735715-163	73561
9F1	Fuse, cartridge, glass body, slow blowing type, 1 amp., 32 v., 1¼" lg. x 3/32" dia.	8835338-9	94877
9F2	Fuse, cartridge, glass body, slow blowing type, 15/100 amp., 250 v., 1¼" lg. x 3/32" dia.	8835338-10	95578
9F3	Fuse, cartridge, glass body, slow blowing type, 8/10 amp., 250 v., 1¼" lg. x 3/32" dia.	8835338-4	95111
9F4	Fuse, cartridge, glass body, slow blowing type, 3/10 amp., 250 v., 1¼" lg. x 3/32" dia.	8835338-3	95110
9F5	Fuse, cartridge, glass body, slow blowing type, 3/10 amp., 250 v., 1¼" lg. x 3/32" dia. (same as 9F4)	8835338-3	95110
9F6, 9F7	Fuse, cartridge, glass body, slow blowing type, 8/10 amp., 250 v., 1¼" lg. x 3/32" dia. (same as 9F3)	8835338-4	95111
9F8, 9F9	Fuse, cartridge, glass body, slow blowing type, 3/10 amp., 250 v., 1¼" lg. x 3/32" dia. (same as 9F4)	8835338-3	95110
9F10, 9F11	Fuse, cartridge, glass body, slow blowing type, 8/10 amp., 250 v., 1¼" lg. x 3/32" dia. (same as 9F3)	8835338-4	95111
9F12, 9F13	Fuse, cartridge, glass body, slow blowing type, 3/10 amp., 250 v., 1¼" lg. x 3/32" dia. (same as 9F4)	8835338-3	95110
9F14, 9F15	Fuse, cartridge, glass body, slow blowing type, 8/10 amp., 250 v., 1¼" lg. x 3/32" dia. (same as 9F3)	8835338-4	95111
9I1 to 9I5 Incl.	Lamp, neon, starting volts 65 vac, 90 vdc, min. bayonet base	872291-9	91749
9J1, 9J2	Connector, male, 6 contact, chassis mtg. type	181494-3	28507
9J3, 9J4	Connector, female, 6 contact, chassis mtg. type	181494-4	18534
9J5	Connector, female, 24 contact, chassis mtg. type	458516-1	95559
9J6	Connector, male, 24 contact, chassis mtg. type	458516-2	95560
9J7	Connector, female, 15 contact, chassis mtg. type	449613-4	95561
9J8	Connector, male, 15 contact, chassis mtg. type	449613-6	95562
9J9, 9J10	Connector, female, 15 contact, chassis mtg. type (same as 9J7)	449613-4	95561
9J11	Connector, male, 6 contact, chassis mtg. type (same as 9J1)	181494-3	28507
9J12	Connector, female, 15 contact, chassis mtg. type (same as 9J7)	449613-4	95561
9K1	Timer, fault lockout, time range 0-57 sec., 115 vac., 60 cy., 2⅞", 2 hole mtg. centers	8835342-1	95563
9K2	Relay, ac., coil 115 v. 60 cy. contacts, 3 form "A" make, 1 form "B" break, 1 form "C" break-make	737869-1	95564
9K3	Relay, ac., coil 115 v. 60 cy. contacts, 2 form "C" break-make	737869-2	95565
9K4	Relay, ac., coil 115 v. 60 cy. contacts, 3 form "A" make, 1 form "B" break, 1 form "C" break-make (same as 9K2)	737869-1	95564
9K5	Relay, ac., coil 115 v. 60 cy., contacts 4 form "C" break-make	737869-3	95566
9K6, 9K7	Relay, ac., coil 115 v. 60 cy. contacts, 3 form "A" make, 1 form "B" break, 3 form "C" break-make	737869-4	95567
9K8, 9K9	Relay, ac., coil 115 v. 60 cy. contacts, 2 form "C" break-make (same as 9K3)	737869-2	95565
9K10	Relay, ac., coil 115 v., 0.1 amps., 60 cy., 145 ohms dc., res. 4 pole double throw contacts	458524-1	95568
9K11	Relay, ac., coil 115 v., 0.1 amps., 60 cy. s.p.d.t. double break contacts 15 amps., 24 vdc or 110 vac non-inductive	458524-2	95569

Symbol No.	Description	Drawing No.	Stock No.
9K12	Relay, ac., coil 115 v., .043 amps., 60 cy. dc res. 445 ohms, d.p.d.t. contacts, 15 amps., 24 vdc or 110 vac, non-inductive	458523-1	95570
9K13	Relay, ac., coil 115 v., 0.1 amp. 60 cy. dc. res. 145 ohms s.p.d.t. double break contacts 15 amps. 24 vdc or 110 vac non-inductive, (same as 9K11)	458524-2	95569
9K14	Relay, ac., coil 115 v., 60 cy. contacts, 2 form "C" break-make (same as 9K3)	737869-2	95565
9K15	Relay, ac., coil 115 v., .043 amps. 60 cy. dc res. 445 ohms d.p.d.t. contacts 15 amps., 24 vdc or 110 vac, non-inductive (same as 9K12)	458523-1	95570
9K16	Relay, ac., coil 115 v., 0.1 amps., 60 cy. s.p.d.t. double break contacts 15 amps., 24 vdc or 110 vac non-inductive (same as 9K11)	458524-2	95569
9K17, 9K18, 9K19	Relay, ac., coil 115 v. 60 cy., contacts, 2 form "C" break-make (same as 9K3)	737869-2	95565
9K20	Relay, dc., dual wound coil, 500/250 vdc, contacts, 1 form "A" make	737886-1	95571
9K21	Relay, ac. or dc. 30 sec. time delay, 115 v. heater voltage s.p.s.t. normally open contacts, 8 pin plug-in type hermetically sealed	458514-61	96729
9K22, 9K23	Relay, ac. or dc., 5 sec. time delay, 115 v. heater voltage, s.p.s.t. normally open contacts, 8 pin plug-in type hermetically sealed	458514-57	97474
9R1 to 9R12 Incl.	Resistor, fixed, composition, 390 ohms ±10% 2 watt	99126-57	523139
9R13	Resistor, fixed, wire wound, 25,000 ohms ±5% 25 watt	427491-40	96264
9R14	Resistor, adjustable, wire wound, 10,000 ohms ±10%, 25 watt	449695-2	97509
9R15 to 9R26 Incl.	Resistor, fixed composition, 470,000 ohms ±10%, 2 watt	99126-94	522447
9R27, 9R28	Resistor, fixed composition, 100 ohms ±10%, ½ watt	82283-50	502110
9S1, 9S2	Switch, toggle, d.p.s.t.10 amps., 250 v. 15 amps. 125 v. ball type handle	889698-1	92998
9S3, 9S4, 9S5, 9S6	Switch, push type, s.p.d.t. 1 amp., 250 v., 3 amps. 125 v. with black bakelite snap on button	8835332-2	95572
Pt. of 9X1	Socket, pilot light, socket only less jewel and lamp	Pt. of 8856279-28	56612
Pt. of 9X2, Pt. of 9X3, Pt. of 9X4, Pt. of 9X5			
Pt. of 9X1, Pt. of 9X4	Jewel, pilot lamp, red jewel only less socket and lamp	Pt. of 8856279-28	56612
Pt. of 9X2, Pt. of 9X3, Pt. of 9X5	Jewel, pilot lamp, opal jewel only less socket and lamp	Pt. of 8856279-22	56611
9X6 to 9X20 Incl.	Holder, fuse, through panel mtg. with twist lock cap	99088-1	58933
9X21, 9X22, 9X23	Socket, tube, octal, black phenolic, with metal mtg. plate (for 9K21, 9K22, and 9K23 relay)	87156-1	31319
	Connector, male, 6 contact cable mtg. type	181494-2	28454
	Connector, male, 15 contact, cable mtg. type	449620-1	95574
	Connector, male, 24 contact, cable mtg. type	449620-2	95576
	Connector, female, 6 contact, cable mtg. type	449614-7	95555
	Connector, female, 15 contact, cable mtg. type	427038-7	58341
	Connector, female, 24 contact, cable mtg. type	449620-3	95852
	Connector, male, 15 contact, cable mtg. type	449620-1	95574
	Connector, female, 6 contact, cable mtg. type	449614-7	95555
	Nut, thumb, brass, knurled head, screw driver slotted front cover holding.	8836043-1	95573
	Relay, plug-in type, coil 8000 ohms, energize max. 1.6 ma, de-energize min. 0.75 ma, contacts s.p.d.t., 150 w. at 115 vac (MI-31021-B Only)	8888583-1	56316
	Screw, thumb, brass, knuried hd. rear cover holding	8886111-2	94391

REPEATER ANTENNA SWITCHING UNIT MI-31029, -B

	Connector, female, coaxial tee type	8845691-1	95396
	Connector, male, 6 contact, chassis mtg. type	181494-3	28507
	Connector, female, coaxial type, "N" less square mtg. flange and "U" shaped beryllium copper contact on other end	Pt. of 744073-1 & 2	96934
	Contact, stationary, center conductor, "U" shaped beryilium copper silver plated, complete with # 2-56 x ¼" lg. screw & 2 lockwasher	Pt. of 744073-1 & 2	96933
	Contact, movable, contact rod assembly, bakelite rod with silver plated contact sleeve and anchor stud & sq. flange on rear (MI-31029 only)	Pt. of 744073-1	97453
	Contact, movable contact rod assy. bakellte rod with silver plated contact sleeve, anchor stud and sq. flange on rear (MI-31029-B early production)	Pt. of 744073-2	97041

Symbol No.	Description	Drawing No.	Stock No.
	Contact, movable contact rod assy. bakelite rod with silver plated contact sleeve, anchor stud and sq. flange on rear (MI-31029-B late production only)	Pt. of 744073-2	96936
	Solenoid, coaxial switch actuating 117 vac 60 cy. intermittent duty	Pt. of 744073-2	96931
	Solenoid, coaxial switch release 117 vac 60 cy. intermittent duty	Pt. of 744073-2	96932
	Spring, coil. 0.325 od. x 2 7/8" lg. actuating coil release	Pt. of 744073-2	96935
	Switch, micro s.p.d.t. normally open or normally closed 110 vac screw type terminal	Pt. of 744073-2	96937
STANDBY LOCKOUT UNIT MI-31055 (FOR CW-20A RECEIVER/MODULATOR MI-31491-A)			
16C1, 16C2	Capacitor, fixed, ceramic, disc type, 10,000 mmf +100%-0% 450 vdc	449696-55	59997
16C3	Capacitor, fixed, paper tubular moulded, 0.1 mf ±10% 400 vdc	735715-175	73551
16C4	Capacitor, fixed, ceramic, 220 mmf ±10% 500 vdc	735717-33	94194
16C5, 16C6	Capacitor, fixed, ceramic, disc type, 10,000 mmf +100%-0% 450 vdc (same as 16C1)	449696-55	59997
16C7	Capacitor, fixed, paper tubular moulded, 0.1 mf ±10% 400 vdc (same as 16C3)	735715-175	73551
16C8, 16C9	Capacitor, fixed, ceramic, disc type, 10,000 mmf + 100%-0% 450 vdc (same as 16C1)	449696-55	59997
16C10	Capacitor, fixed, paper tubular moulded, 0.1 mf ±10% 400 vdc (same as 16C3)	735715-175	73551
16C11	Capacitor, fixed, paper tubular moulded, .047 mf ±10% 200 vdc	735715-71	73558
16CR1	Rectifier, crystal diode	CK-705	94229
16J1	Connector, female, single contact, pin jack type, for .080 dia. pin	742565-1	93678
16R1	Resistor, fixed, composition, 470,000 ohms ±10% ½w	82283-94	502447
16R2	Resistor, fixed, composition, 3900 ohms ±5% ½w	82283-173	502239
16R3	Resistor, fixed, composition, 220,000 ohms ±5% ½w	82283-215	502422
16R4	Resistor, variable, composition, 1 meg. ±20% 1 w. screw driver slotted shaft	441392-14	68452
16R5	Resistor, fixed, composition, 100,000 ohms ±10% ½w	82283-86	502410
16R6	Resistor, fixed, composition, 3900 ohms ±5% ½w. (same as 16R2)	82283-173	502239
16R7	Resistor, fixed, composition, 220,000 ohms ±5% ½w. (same as 16R3)	82283-215	502422
16R8	Resistor, fixed, composition, 680 ohms ±10% ½ w	82283-96	30562
16R9	Resistor, fixed, composition, 3900 ohms ±5% ½w. (same as 16R2)	82283-173	502239
16R10	Resistor, fixed, composition, 100,000 ohms ±10% ½w. (same as 16R5)	82283-86	502410
16R11	Resistor, fixed, composition, 220,000 ohms ±5% ½ w. (same as 16R3)	82283-215	502422
16R12	Resistor, fixed, composition, 100,000 ohms ±10% ½w. (same as 16R5)	82283-86	502410
16R13	Resistor, fixed, composition, 560,000 ohms ±10% ½ w	82283-95	502456
16R14	Resistor, fixed, composition, 3300 ohms ±5% ½ w	82283-171	30733
16R15	Resistor, fixed, wire wound, 56,000 ohms ±5% 10 w. ceramic insulated	428781-54	53702
16R16	Resistor, fixed, composition, 270,000 ohms ±5% ½ w	82283-217	502427
16R17	Resistor, fixed, composition, 470,000 ohms ±10% ½ w. (same as 16R1)	82283-94	502447
16X1, 16X2	Socket, tube, 9 pin min. natural phenolic, shield base type	984055-2	56333
16X3	Socket, relay, tube socket type 5 contact, with metal mtg. plate	849224-1	43639
	Relay, dc., plug-in type, coil 8000 ohms, energize 1.6 ma max. de-energize 0.75 ma min., contacts s.p.d.t. 1150 w. at 115 vac	8888583-1	56316
	Shield, tube for 9 pin min. tube (for 16V1 and 16V2)	8858642-3	57533

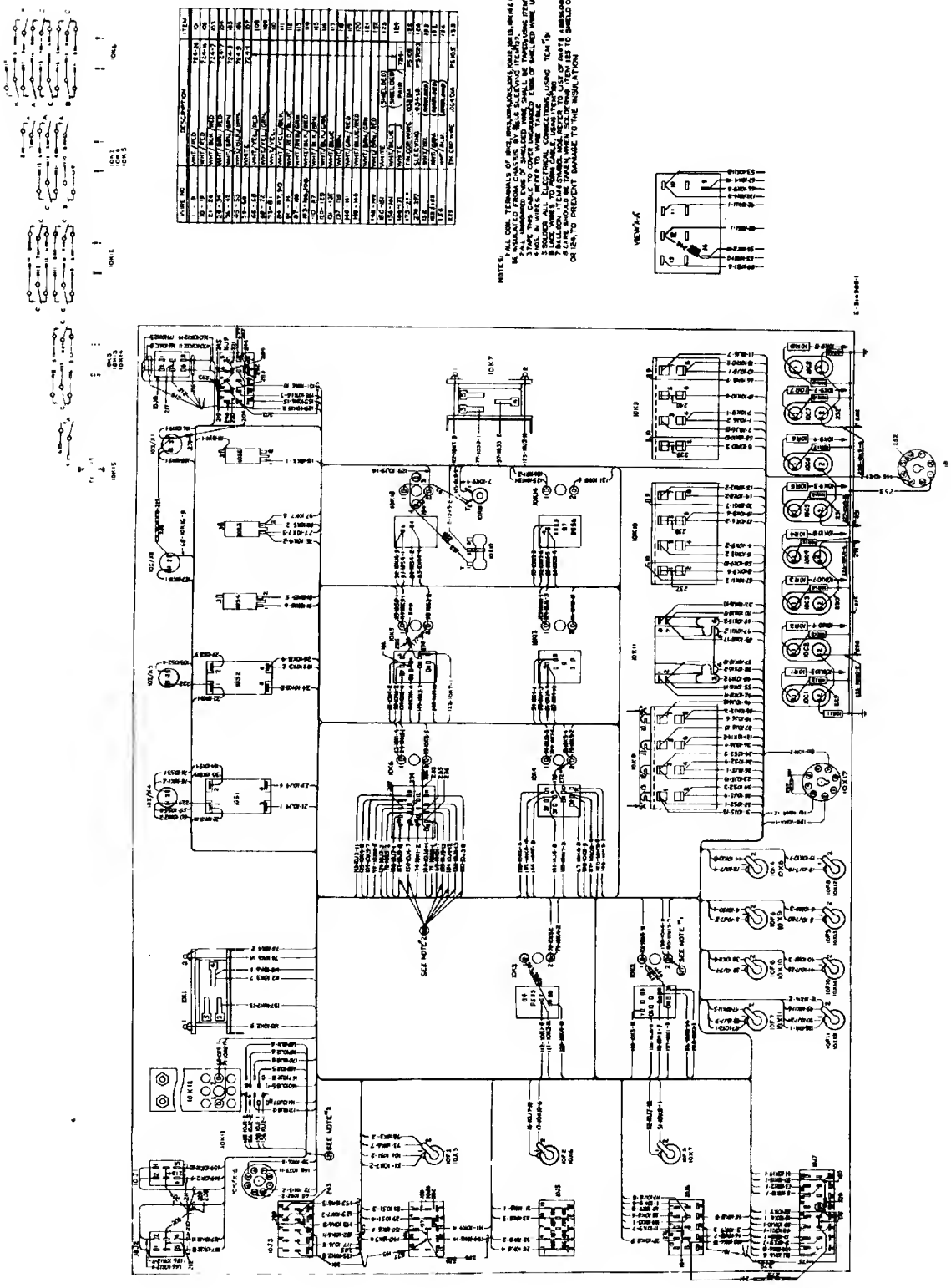


Figure 32—Terminal Switching Unit, MI-31022-B, Item 1, Connection Diagram

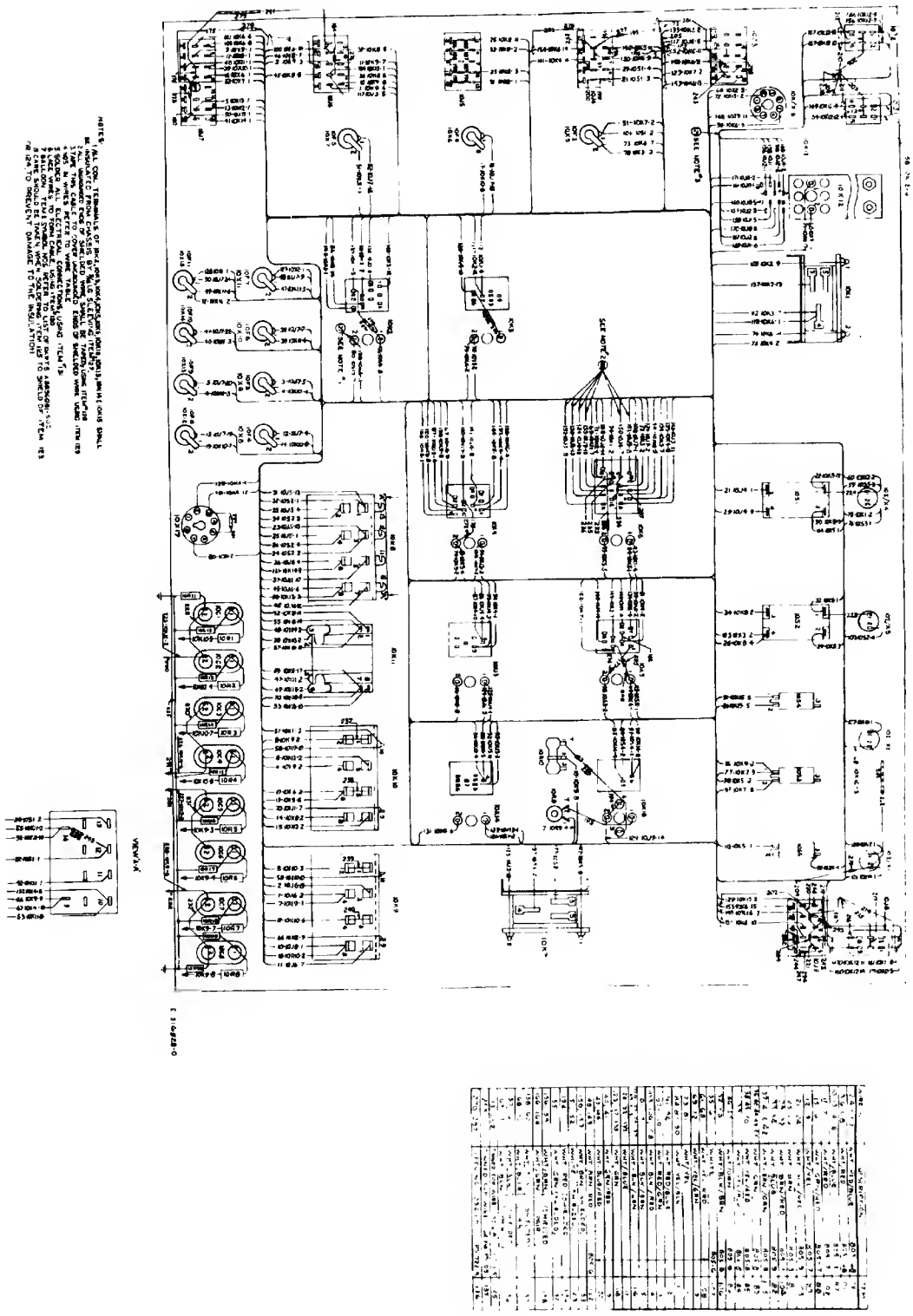


Figure 32A—Terminal Switching Unit, MI-31022-C, Item 1, Connection Diagram

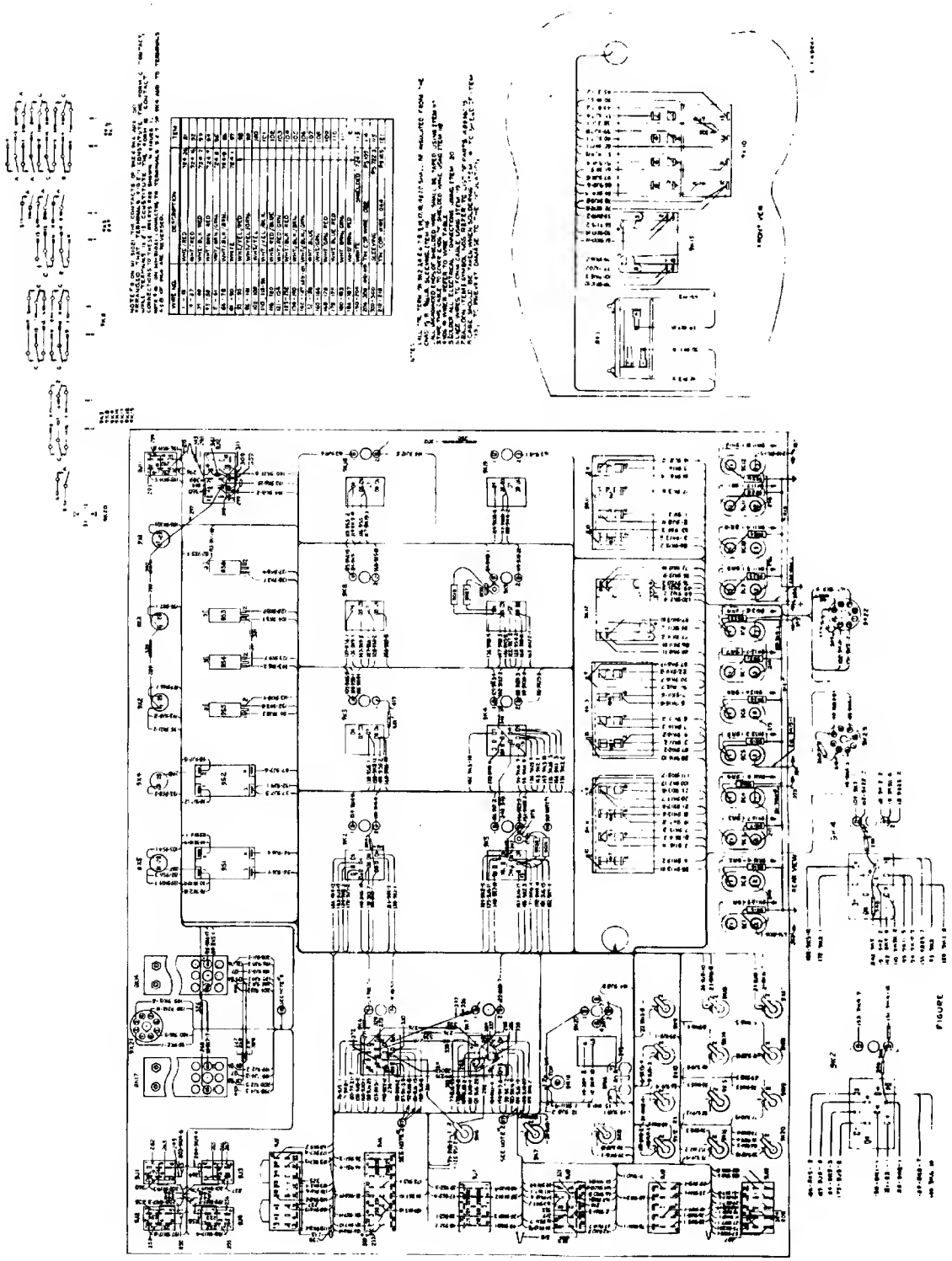


Figure 33—Repeater Switching Unit, MI-31021-B—Connection Diagram